



ENVIRONMENTAL HEALTH PROJECT

Best Practices for Dengue Prevention and Control in the Americas

Linda S. Lloyd

Environmental Health Project
Contract HRN-I-00-99-00011-00
is sponsored by
Office of Health, Infectious Diseases and Nutrition
Bureau for Global Health
U.S. Agency for International Development
Washington, DC 20523





Strategic Report 7

Best Practices for Dengue Prevention and Control in the Americas

by

Linda S. Lloyd

February 2003

Prepared for the USAID Bureau for Latin America and Caribbean
under EHP Project 26568/E.V.4.LACDENGUE

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Acknowledgements

This document would not have been possible without the collaboration of many people, first and foremost the contributors of the Best Practices. Although the timeline was a tight one, the contributors were prompt in submitting their best practices and responding to questions. I owe many thanks to my colleagues who shared their technical expertise with me while I put the document together and who served as reviewers: Jorge Arias (PAHO), Gary Clark CDC), Mike Nathan (WHO), Will Parks (WHO), and José Rigau (CDC). In addition, thanks are due to reviewers whose comments helped strengthen the document: Alba Amaya (USAID), Jaime Chang (USAID), Matt Lynch (USAID), Merri Weinger (USAID). Finally, it has been a pleasure working with EHP staff, in particular Fred Rosensweig, whose comments and suggestions have been not only perceptive but most helpful.

Abbreviations

CDC	Centers for Disease Control and Prevention
CFR	case fatality rates
CI	confidence interval
CVP	central venous pressure
DF	dengue fever
DHF	dengue hemorrhagic fever
DSS	dengue shock syndrome
EHT	environmental health technician
ELISA	enzyme-linked immunosorbent assay
FUNASA	Fundação Nacional de Saúde
GIS	geographic information system
HQ	headquarters
KAPB	Knowledge, attitudes, practices and behavior
MOH	Ministry of Health
MSDS	Ministry of Health and Social Development
NEPRAM	Negociación de Prácticas Mejoradas (Negotiating Improved Practices)
NGO	nongovernmental organization
PAHO	Pan American Health Organization
PCR	polymerase chain reaction
ULV	ultra-low volume
UNICEF	United Nations Children's Fund (per the UNICEF website)
USAID	United States Agency for International Development
WHO	World Health Organization

Executive Summary

In response to the growing need of health staff to address dengue prevention and control, the United States Agency for International Development (USAID) Bureau for Latin America and Caribbean requested a document that describes current thinking and practices for the prevention and control of dengue fever. The conceptual framework for the document is that of comprehensive, integrated dengue prevention and control, a framework the Pan American Health Organization (PAHO) proposed in 1994. This framework is supported by the U.S. Centers for Disease Control and Prevention (CDC), Dengue Branch, and the World Health Organization (WHO). The document adopts the 10 key elements for a comprehensive, integrated dengue program that PAHO enumerated in the “Decalogue” (2001). These elements address all aspects of comprehensive dengue prevention and control:

- Integrated epidemiological and entomological surveillance
- Advocacy and implementation of intersectoral actions
- Effective community participation
- Environmental management and addressing basic services
- Patient care within and outside of the health system
- Case reporting
- Incorporation of the subject of dengue/health into formal education
- Critical analysis of the use and function of insecticides
- Formal health training of professionals and workers both in the medical and social sciences
- Emergency preparedness.

These 10 elements reflect the five key elements that WHO defined (1996) as essential components for the global strategy on dengue.

Dengue fever is the most important mosquito-borne viral disease affecting humans, with the mosquito vector found in nearly 100 tropical countries. The global distribution of *Aedes aegypti*, the mosquito vector for the dengue viruses, is comparable to that of malaria, and an estimated 2.5 billion people live in areas at risk for epidemic transmission. As the number of cases of dengue fever (DF) and dengue hemorrhagic fever (DHF) continues to grow unabated in the region of the Americas, with annual epidemics resulting in hundreds of thousands of DF/DHF cases and no

measurable impact of current vector control practices on *Aedes aegypti* populations, a renewed attention to integrated dengue prevention and control strategies is urgently needed. A record number of 968,723 cases of DF/DHF were reported in the region for the year 2002, with 17,386 confirmed cases of DHF and 234 confirmed DHF-related deaths.

Meltzer, et al. (1998) state that the global burden of dengue could be as significant as diseases such as malaria and tuberculosis, with DF/DHF epidemics placing significant economic burdens on communities and governments. The impact of DF/DHF can be measured in tangible economic terms, such as unplanned budgetary allocations to combat the epidemic, medical care costs for inpatient and outpatient care, days of lost work due to illness or to care for an ill family member, as well as intangible economic impacts, such as increased household expenditures to purchase mosquito repellents and medications, a decline in household income due to lost days of work, and the loss of tourism as a result of fear of contracting the disease. Continued epidemics of DF/DHF highlight the lack of impact current dengue control program strategies have on controlling the mosquito vector and the critical need for all program components to be evaluated and monitored for effectiveness in the field.

Currently, most national programs are ill equipped to manage the prevention and control aspects of a dengue program, and rely heavily on chemical control methods. Operationally, the majority of national dengue control programs provide emergency response to epidemics and are unable to effect sustained control of the proliferation of the mosquito. Larval habitats are increasing in urban areas at an alarming rate. This is primarily due to the high costs of running vertical programs that would function at the previous level (100% of households inspected every three months), increased urbanization with peri-urban areas lacking in basic infrastructure, the widespread use of nonbiodegradable items with a concurrent lack of adequate trash disposal and sanitary landfill systems, and governments struggling to control unplanned growth. The primary activity of dengue control programs is the control of larval habitats of *Ae. aegypti* as a means to reduce the adult mosquito population and, as a result, decrease disease transmission. This approach relies heavily on community participation in control activities, yet most dengue control programs are unprepared to develop and manage sustained community participation strategies.

This report includes 11 examples of practices currently in use in several countries, nine from the Americas, one from Southeast Asia, and one of global application. The practices, written by individuals involved in the development and implementation of the practice, cover a wide range of activities that would be expected from an integrated dengue prevention and control program. Unfortunately, a best practice could not be found for each key element of the PAHO Decalogue, while other solicited best practices were not received in time for publication. The best practices included in this document are as follows:

- A global dengue surveillance system (WHO)
- A weekly epidemiological report (Venezuela)

- The dengue diagnostic laboratory (CDC Dengue Branch, Puerto Rico)
- Social mobilization of city residents for dengue (Brazil)
- Key container and key premise indices for *Aedes aegypti* surveillance and control (Vietnam)
- Management and control of tires (Mexico)
- Management and control of water containers (Dominican Republic)
- Clinical case definitions for dengue fever, dengue hemorrhagic fever, and dengue shock syndrome (CDC Dengue Branch, Puerto Rico)
- Case treatment and management (CDC Dengue Branch, Puerto Rico)
- Primary school curriculum for comprehensive vector control (English-speaking Caribbean)
- Cross-training of Ministry of Health and municipal government staff (Honduras).

These examples have been termed “best practices” since they have been evaluated for effectiveness and are in use as part of broader programs. These best practices are not intended to be prescriptive nor can they, with the exception of the case definitions, clinical case management, and laboratory practices, be transferred from one setting to another without prior field testing. The practices should also not be viewed as a panacea for dengue prevention and control. Rather, they are examples of specific components of several programs, developed in many cases according to cultural and ecological circumstances. It is hoped that the inclusion of descriptions of the processes to develop the practice in four of the 11 practices (Brazil, Vietnam, Mexico, and Dominican Republic) will provide sufficient information to encourage other countries to conduct similar operational research activities.

The annexes in this document provide information on international organizations involved in dengue prevention and control, contact information for further information and technical assistance, and resources that can be found on the Internet. It is hoped that this document will stimulate further discussions on how to strengthen dengue prevention and control actions that are implemented regularly rather than on an emergency basis, how to sustain resources over several years so that truly effective control strategies can be tested and implemented, and how to encourage routine monitoring and field evaluation of all activities so that program staff and affected communities know that the actions are effective at the individual or community level.

1. Introduction

1.1. Rationale

The incidence (this refers to incidence rates) of dengue fever (DF) and dengue hemorrhagic fever (DHF) continue to grow globally. In the region of the Americas the pattern follows what was seen in Asia 30 years ago. Today, dengue is the most important mosquito-borne viral disease affecting humans, with *Aedes aegypti*, the mosquito vector for the dengue viruses, found in nearly 100 tropical countries. Its global distribution is comparable to that of malaria, and an estimated 2.5 billion people live in areas at risk for epidemic transmission (CDC, <http://www.cdc.gov/ncidod/dvbid/dengue>; PAHO, <http://www.paho.org/english/HCP/HCT/VBD/dengue.htm>). Each year, there are an estimated 50–100 million cases of DF and, depending on the year, 250,000–500,000 cases of DHF. The case-fatality rate for DHF ranges by country, although the average is about 5%, and most fatal cases are among children and young adults.

Epidemic DHF first appeared in the 1950s in Southeast Asia, and by 1975 it had become a leading cause of hospitalization and death among children in many countries in that region. In the 1980s, DHF began a second expansion into Asia, and in countries where DHF is endemic, the epidemics have become progressively larger over the last 15 years (CDC, <http://www.cdc.gov/ncidod/dvbid/dengue>). Prior to 1970, only nine countries had experienced DHF epidemics (WHO, http://www.who.int/health_topics/dengue/en).

The emergence of DF/DHF as a major public health problem has been most dramatic in the region of the Americas. The mosquito vector of DF/DHF was eradicated in most of the region as part of the Pan American Health Organization's (PAHO) yellow fever eradication campaign in the 1950s and 1960s. The *Ae. aegypti* eradication program, officially discontinued in the United States in 1970, gradually eroded throughout the region, leading to reinfestation of the mosquito vector in most countries during the 1980s and 1990s (CDC, <http://www.cdc.gov/ncidod/dvbid/dengue>). By 1997, the geographic distribution of *Ae. aegypti* was wider than its distribution before the eradication program (Figure 1), 18 countries had reported confirmed DHF cases, and DHF is now endemic in much of the region of the Americas (Figure 2). Hyperendemicity, the presence of multiple circulating serotypes, is seen in most countries in the region, and epidemics caused by multiple serotypes are more frequent.

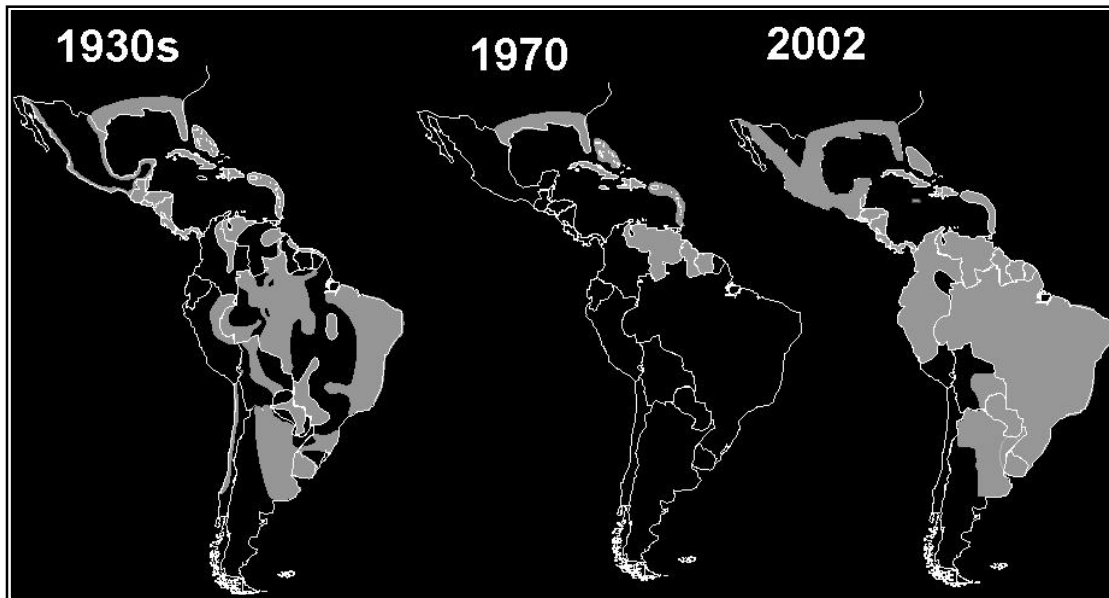


Figure 1: Reinfestation of *Aedes aegypti* in the Americas

Source: PAHO, 2001



Figure 2: The Evolution of DHF

Source: PAHO, 2001 and http://www.paho.org.English/hct/vbd/dengue_timeline.xls

1.1.1. Factors leading to increased numbers of *Ae. aegypti* larval habitats

The reasons for this dramatic emergence of DF/DHF as a major public health problem are complex, although several important factors have been identified (CDC, <http://www.cdc.gov/ncidod/dvbid/dengue>; PAHO, 2001; WHO, 2003):

1. *Effective mosquito control is virtually nonexistent* in most dengue-endemic countries, and emphasis has been placed on ultra-low volume insecticide space sprays for adult mosquito control, a relatively ineffective approach for controlling *Ae. aegypti*.
2. Major global demographic changes, primarily *uncontrolled urbanization and concurrent population growth*, have occurred, resulting in substandard housing and inadequate water, sewer, and waste management systems.
3. There have been significant increases in the *use of nonbiodegradable packaging*, compounded by nonexistent or ineffective trash collection services.
4. Ongoing large-scale *import and export of used tires* infested with *Ae. aegypti* larvae.
5. *Increased travel by airplane* has resulted in a constant exchange of dengue viruses and other pathogens.
6. *The reality of limited financial and human resources has resulted in a "crisis mentality"* with emphasis on implementing emergency control methods in response to epidemics rather than on developing programs to prevent epidemic transmission.

Because most national programs are not equipped to manage the prevention and control aspects of a dengue program, heavy reliance continues to be placed on chemical control methods and outdated strategies. The sad reality is that the majority of national dengue control programs are based on emergency responses to epidemics, and there are no staff or resources to implement integrated strategies for dengue prevention and control during interepidemic years. The vertical structure of most dengue programs, based upon vector control field workers visiting every household in a specific area on an established cycle (ideally four times a year), was developed 60 years ago for yellow fever eradication. Today, this structure is not possible given increasing urbanization, budgetary constraints, lack of personnel, the presence of increasing numbers of “closed” households (no one home during the day to allow access to the house or the premise), and householder rejection of the use of larvicides in domestic water-holding containers used to store drinking water.

1.1.2. Economic impact of DF and DHF

The economic impact of DF/DHF is enormous, placing significant burdens on affected communities. This impact varies and can include loss of life; medical expenditures for hospitalization of patients; loss in productivity of the affected workforce; strain on health care services due to sudden, high demand during an epidemic; considerable expenditures for large-scale emergency control actions; and loss of tourism as a result of negative publicity (Meltzer et al., 1998; CDC, <http://www.cdc.gov/ncidod/dybid/dengue>; PAHO, <http://www.paho.org/english/HCP/HCT/VBD/dengue.htm>). Although there are few studies of the economic impact of a DF/DHF epidemic, Von Allmen et al. (1979) estimated the cost of the 1977 dengue epidemic in Puerto Rico to be between US\$6 and \$16 million. The authors estimated the direct costs (medical care, epidemic control measures) of the epidemic were between US\$2.4 and \$4.7 million, while indirect costs (days of work lost by ill workers and parents of ill children) were between US\$3.7 and \$11 million. A cost analysis of the 1981 Cuban dengue epidemic conducted by Kouri et al. (1989) estimated the total cost of the epidemic to be US\$103 million, with an estimated US\$84 million in direct costs and US\$19 million in indirect costs. According to Meltzer et al. (1998), the global burden of dengue could be as significant as diseases such as malaria and tuberculosis, both of which receive greater political and financial support than dengue (see also Gubler and Meltzer, 1999).

As seen in Table 1, the number of cases of DF and DHF in the region of the Americas continues to grow annually, resulting in an increased burden of disease and economic expenditures throughout the region. This year, the total number of cases of DF and DHF for the region almost reached 1 million.

Table 1. Number of Reported Cases of Dengue Fever and Dengue Hemorrhagic Fever, Region of the Americas, by Subregion and Year

	Andean		Central America		Southern Cone		Caribbean		Total	
	DF/DHF	DHF ^a /Deaths	DF/DHF	DHF/Deaths	DF/DHF	DHF/Deaths	DF/DHF	DHF/Deaths	DF/DHF	DHF ^a /Deaths
2002^b	111,138	8,641/12	71,775	4,502/36	760,699	2,572/145	14,925	285/35	968,723	17,386/234
2001	173,079	13,410/73	33,785	1,182/28	413,116	679/29	19,023	233/8	639,003	15,504/138
2000	72,376	1,827/24	60,152	1,460/55	257,453	59/3	10,542	140/15	400,523	3,486/97
1999	50,550	3,781/30	56,926	1,228/24	205,368	70/3	9,412	137/25	322,256	5,216/ 82
1998	106,411	10,894/97	71,137	827/25	536,210	105/10	28,036	543/19	741,794	12,369/151
1997	63,711	10,250/71	91,243	1,074/40	254,109	35/5	12,935	424/37	421,998	11,783/153
1996	53,971	3,437/24	51,964	1,525/44	175,818	1,826/12	9,815	44/7	291,568	6,832/ 87
1995	92,685	6,408/57	105,365	1,494/39	124,887	112/2	11,483	213/15	334,420	8,227/113

^a Cases of DHF only; ^b 2002: as of January 8, 2003

Source: <http://www.paho.org/english/HCP/HCT/VBD/dengue.htm> (Regional data compiled by PAHO from country reports to PAHO of data originating from the respective Ministries of Health).

1.2. Purpose of this Document

To reduce the burden of DF and DHF, new approaches to fully integrate disease and vector surveillance, vector control, clinical case management, and training of health personnel are needed. The United States Agency for International Development (USAID) LAC Bureau requested this document in response to the growing need of USAID health staff, as well as national dengue program staff, to address dengue prevention and control. This document will provide examples (e.g., “best practices”) of current international efforts to strengthen integrated approaches to dengue fever prevention and control, with the intent that the best practice, or the process to develop a best practice, may be relevant to other dengue-endemic countries. This document should not be viewed as a comprehensive dengue program guide, which has already been published by PAHO and the World Health Organization (WHO) (PAHO, 1994 and 2001; WHO, 1996), nor should it be viewed as a prescription that will provide immediate programmatic results. Rather, these examples provide a snapshot of efforts currently underway that have demonstrated some degree of effectiveness and sustainability.

The majority of the best practices are taken from the region of the Americas, with the exception of a global dengue surveillance system supported by WHO and the development of vector surveillance surveys to strengthen local control strategies in Vietnam.

1.3. Description of DF and DHF

DF and DHF are caused by one of four closely related, but antigenically distinct, dengue virus serotypes designated as DEN-1, DEN-2, DEN-3, and DEN-4 of the genus *Flavivirus*. Infection with one of these serotypes provides lifelong immunity against that serotype, but it does not provide cross-protective immunity against the other three. There is evidence that sequential infection increases the risk of the more severe disease, DHF. Persons living in a dengue-endemic area can have up to four dengue infections, thereby putting them at risk for DHF with each subsequent infection.

A major challenge for disease surveillance and case diagnosis is that the dengue viruses produce asymptomatic infections and a spectrum of clinical illness ranging from a mild, nonspecific viral syndrome to fatal hemorrhagic disease. Important risk factors for DHF include the strain and serotype of the infecting virus, as well as the age, immune status, and genetic predisposition of the patient (PAHO, 1994; CDC, <http://www.cdc.gov/ncidod/dvbid/dengue>).

Dengue fever

Dengue fever is an acute febrile viral disease with clinical features that vary widely (PAHO, 1994). It may present as an undifferentiated febrile illness with a

maculopapular rash (often seen in children), a mild febrile syndrome similar to the flu, or the classical disease with two or more of the following manifestations: fever, headache, bone or joint pain, muscular pain, rash, pain behind the eyes, hemorrhagic manifestations (e.g., petechiae). In adults, recovery may be associated with prolonged fatigue and depression. During dengue epidemics, hemorrhagic complications may also appear, such as bleeding from the gums, nosebleeds, and bruising. It is very important to distinguish between DF with hemorrhagic symptoms and DHF so that appropriate therapy can be initiated in the case of DHF. Case fatality due to DF is very low, but case fatality due to DHF can be high (PAHO, 1994; WHO, 1997). There is no specific treatment for DF beyond symptomatic treatment, rest, and rehydration.

Dengue hemorrhagic fever/dengue shock syndrome

Cases of DHF are characterized by four clinical manifestations, all of which must be present: (1) fever or recent history of acute fever, (2) hemorrhagic phenomena (presence of at least one of the following: positive tourniquet test; petechiae, ecchymoses, or purpura; or bleeding from mucosa, gastrointestinal tract, injection sites, or others), (3) thrombocytopenia ($100,000 \text{ mm}^3$ or less), and (4) plasma leakage due to increased capillary permeability (PAHO, 1994). Moderate to marked thrombocytopenia with concurrent hemoconcentration is a distinctive clinical laboratory finding of DHF. However, the major pathophysiological change that determines the severity of disease in DHF, and differentiates it from DF, is plasma leakage manifested by a rising hematocrit value (i.e., hemoconcentration).

The normal course of DHF lasts between seven and ten days, and with appropriate intensive supportive therapy—maintenance of the circulating fluid volume is the central feature of DHF case management—mortality may be reduced to less than 1%. In severe cases of DHF, the patient's condition may suddenly deteriorate after a few days of fever; the temperature will drop, followed by signs of circulatory failure; and the patient may rapidly go into a critical state of shock (dengue shock syndrome) and die within 12-24 hours, or quickly recover following appropriate volume replacement therapy.

Dengue shock syndrome (DSS) is the most severe form of DHF, and is characterized by the presence of all four DHF clinical manifestations as well as circulatory failure. All three manifestations of circulatory failure must be present: rapid and weak pulse, narrow pulse pressure or hypotension for age of patient, and cold, clammy skin and altered mental state. For further information regarding clinical case management of DHF and DSS, the reader should consult the PAHO (1994) (<http://www.paho.org/english/HCP/HCT/VBD/dengue.htm>) and WHO (1997) guidelines (http://www.who.int/health_topics/dengue/en), the CDC Dengue website (<http://www.cdc.gov/ncidod/dvbid/dengue>), and the article by Rigau-Pérez, et al. (1998) .

1.4. Current International and Regional Efforts in Dengue Prevention and Control

Over the past 15 years, health organizations have attempted to expand an understanding of the disease, its vector dynamics, and the ongoing creation and maintenance of potential breeding sites by populations at risk for DF and DHF. Results of these efforts can be seen in the development of integrated *Ae. aegypti* prevention and control strategies promoted by PAHO and WHO since the mid-1990s, and the recent passage of resolutions recommending that member states develop comprehensive, integrated DF/DHF prevention and control programs (PAHO: Directing Council Resolution CD43.R4, 2001; WHO: World Health Assembly Resolution WHA55.17, 2002).

PAHO

- In 1994, the dengue prevention and control guidelines were revised, with a clear focus on an integrated, comprehensive dengue prevention and control program along with a greater emphasis on community participation, community-based control strategies, and planning for communications and health education activities.
- In 1997, PAHO published the *Hemispheric Plan to Expand and Intensify Efforts to Combat Aedes Aegypti*—a plan that emphasized the role of community participation and social communications as components of national programs. The *Hemispheric Plan* also called for allocation of 10% of the *Ae. aegypti* vector control budget to support the community participation and social communications components.
- In 1999, PAHO issued *The Blueprint for Action for the Next Generation: Dengue Prevention and Control* to reinforce the directive established for community participation and social communications, as specified in the *Hemispheric Plan*.
- In 2001, the resolution of the PAHO Directing Council (CD43.R4) established a model for the prevention and control of dengue, with a goal of showing member states how to move from vertical vector control models to horizontal vector control programs. This is especially important given health sector reform efforts currently underway in the region, and the fact that most local health services, now responsible both politically and administratively for prevention programs, are not sufficiently established to take on these programs. Local health departments, be it at the regional, state, or municipal levels, have generally not had access to the levels of technical staff found at the central Ministry of Health offices, yet they are tasked with implementing the regional integrated strategy defined in 1994, and expanded upon in 1997, 1999, and 2001.

- In October 2001, PAHO published the *Framework: New Generation of Dengue Prevention and Control Programs in the Americas*. The *Framework* document includes the Resolution (CD43.R4) passed in September 2001, and delineates the 10 key elements (the Decalogue) of the regional integrated strategy.

WHO

- In 1995, WHO developed a global strategy to focus and coordinate national efforts on an integrated strategy (WHO, 1996).
- In 1997, WHO revised the *Dengue haemorrhagic fever: Diagnosis, treatment, prevention and control* manual.
- In 2002, the World Health Assembly adopted Resolution WHA55.17 (May, 2002) in which member states were asked to support the global strategy, and both member states and the director general were requested to allocate funds specifically for improved and sustained prevention and control efforts. The global strategy delineates the five essential components of the global strategy.
- In 2002, WHO produced a step-by-step guide to help program managers develop behaviorally focused social mobilization and communications plans for DF/DHF prevention and control (WHO, 2003). This guide, reflecting a renewed interest in measurable behavioral outcomes as an integral part of DF/DHF prevention and control programs, is the result of discussions over several years with researchers, dengue program managers, and staff in health promotion/communications departments, who have been frustrated by the lack of behavior change at all levels, including organizational, programmatic, and community; continued high *Ae. aegypti* infestation rates; and annual epidemics of DF and, now, DHF.

1.5. Organization of this Document

In the following section, the conceptual framework for a comprehensive, integrated dengue prevention and control program is presented. Following the description of the conceptual framework and the 10 key elements of the framework (the PAHO “Decalogue”; www.paho.org/English/HCP/HCT/VBD/dengue-nueva-generacion.htm), the reader will find a series of “best practices,” one for each key element. These examples are intended to illustrate not only what a “best practice” for the specific element is but, where possible, the process used to develop the practice. Each best practice is an independent example, allowing the reader to read individual practices without reading the entire section.

The best practices are not intended to be prescriptive approaches that will work in every setting. Some examples, e.g., clinical case definitions, case treatment and management, and laboratory diagnosis, describe the standards that PAHO, WHO, and the CDC set for countries to strive to reach, while others present both the best practice and the process used to develop it, e.g., vector control, mass mobilization, and school-

based education. The latter set of best practices reflects local conditions that required new approaches to effective dengue prevention and control, and therefore formative research (e.g., identification of principle mosquito breeding sites, field testing the behavior, determination of preferred communication channels being some of the areas to be researched) should be conducted prior to introduction of the best practice into other settings. Unfortunately, a best practice could not be found for every component (e.g., approaches for working with businesses), while other solicited best practices were not received in time for publication. It is important to keep in mind that the best practices presented in this document are examples of specific components of several programs and that no one dengue program was identified as being a model program.

The series of best practices demonstrate that achieving an integrated dengue prevention and control program takes time, commitment, political will, and consistent efforts in working toward this goal. The conclusion, found in Section 4, presents some ideas for next steps, and additional resources can be found in the annexes.

2. Conceptual Framework

The conceptual framework for this document is a comprehensive, integrated dengue fever prevention and control that places equal weight, including fiscal and human resources, on all elements of the program. Comprehensive program strategies address several public health problems as part of the dengue control program; for example, combining *Culex* species control, a far greater nuisance mosquito, with *Aedes* control will provide benefits to the dengue program since nuisance mosquito populations should be reduced. An integrated program uses all potential vector control techniques in the most effective, economical, and safe manner to maintain vector populations at acceptable levels. This conceptual framework, therefore, calls for programs to address not only *Ae. aegypti* infestations, but also other vector populations (rodents, other mosquito species, flies) that the community has identified as problematic, with a rational balance of physical, chemical, and biological control methods.

Currently, most if not all countries in the Americas have a national plan of action for dengue prevention and control that, on paper, demonstrates some level of commitment to an integrated strategy. However, operationally most programs function as vertical *Aedes aegypti* control programs implementing emergency mosquito control activities in response to increasing cases of dengue. Few programs can demonstrate any positive impact of current operational strategies on the prevention of epidemics, as evidenced by continuing epidemics of DF/DHF throughout the region. Implementation of a comprehensive, integrated dengue control program **will not** prevent cases of dengue or even DHF. It should, however, prevent large-scale epidemics and reduce the impact of DF/DHF on affected populations.

The failure of traditional, vertically organized *Ae. aegypti* eradication programs to provide sustained control of the proliferation of the mosquito has motivated a paradigm shift in thinking about DF and control of its mosquito vector. Larval habitats are increasing at an alarming rate for several reasons: the rapidly increasing costs of running vertical programs that function at previous levels, the widespread use of nonbiodegradable items with a concurrent lack of adequate trash disposal and sanitary landfill systems, increased urbanization with peri-urban areas lacking in basic infrastructure, and governments struggling to control unplanned growth. At this time, the only methods for controlling DF/DHF epidemics are to reduce human-vector contact and control larval habitats in a variety of areas, such as homes, businesses, informal dump sites, municipal landfills, and empty lots. These methods rely heavily on community participation in routine source reduction (the control of mosquito habitats) activities, yet most dengue control programs are ill equipped to develop and manage sustained community participation strategies.

The first step to shifting from the current program structure of emergency mosquito control to a truly integrated dengue prevention and control program would be a behavior change on the part of governments and the Ministry of Health (MOH), resulting in their desire to fund and implement all elements of a comprehensive, integrated program. This commitment would include multiyear funding to allow the program to establish new policies and procedures, annual funding to support formative and operations research, annual funding to support community-based activities, and a programmatic emphasis on regular field evaluation of all program activities. Until this occurs, it is unlikely that there will be any change in current dengue transmission patterns since little programmatic support exists for the implementation of comprehensive, integrated dengue prevention and control using methods with demonstrated field efficacy.

2.1. Key Elements of the Conceptual Framework

The 10 key elements of PAHO's regional strategy (the Decalogue) have been adopted as the specific components of the comprehensive, integrated dengue prevention and control program. The elements enumerated in the PAHO Decalogue were generally described in the 1994 PAHO dengue guidelines and other PAHO and WHO documents, for example, the WHO global strategy (1996). The 10 key elements are described in Box 1.

**Box 1. PAHO: The Integrated Strategy for DF/DHF Prevention and Control:
The Decalogue (October 2001)**

- II. Integrated epidemiological and entomological surveillance.
 - II. Advocacy and implementation of intersectoral actions between health, environment, and education as well as other sectors such as industry and commerce, tourism, legislation, and judiciary.
 - III. Effective community participation.
 - IV. Environmental management and addressing basic services such as water supply, disposal of used water, solid waste management, and disposal of used tires.
 - V. Patient care within and outside of the health system.
 - VI. Case reporting, including clinical cases, confirmed cases, DHF and deaths due to DHF, circulating serotypes.
 - VII. Incorporation of the subject of dengue/health into formal education.
 - VIII. Critical analysis of the use and function of insecticides.
 - IX. Formal health training of professionals and workers both in the medical and social sciences.
 - X. Emergency preparedness, establishing mechanisms, and plans to face outbreaks and epidemics.
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2.2. The 10 Essential Elements of a Dengue Prevention and Control Program

The following key elements for a comprehensive, integrated dengue prevention and control program are taken from the Decalogue, PAHO's regional integrated strategy. The Decalogue was selected because the 10 elements reflect program components that the international agencies responsible for developing dengue guidelines (WHO, PAHO, CDC) have recommended, but they have been insufficiently implemented (e.g., effective community participation), or they reflect "new" actions that have become increasingly important (e.g., advocacy for vector control budgets that reflect the true cost of effective routine control activities). A short description of current MOH or dengue prevention and control program practices, and recommendations to improve or strengthen current practices follows each element.

I. Integrated epidemiological and entomological surveillance

Currently, most epidemiological and entomological surveillance systems are separate, vertical structures located in different departments of the MOH. Dengue program managers are dependent upon reporting mechanisms unique to each department, and therefore the data collected may not overlap sufficiently. Another major problem is the lack of communication between departments, with most MOHs unable to provide program managers real-time data that can be used for decision making regarding appropriate vector control strategies or the declaration of an alert for the health system due to increasing cases of DF. Epidemiological reports are sent, frequently by mail, to the vector control department with a resulting one- to three-week lag in receipt (data collected during external evaluations of national dengue control programs, L.S. Lloyd).

The majority of countries collect dengue-related information through a passive surveillance system that relies on physicians to report suspected cases of DF and DHF and to send blood samples that have been collected at defined times during the course of the illness to the national public laboratory system. Passive surveillance is not sensitive enough for early detection of epidemics since not all clinical cases are correctly diagnosed, especially at the beginning of an outbreak when physicians may not suspect dengue, and mild cases may not enter the health care system at all. By the time a significant rise in the number of reported cases is detected, the epidemic may already be peaking or on the decline.

A detailed description of the minimum requirements for epidemiological and entomological surveillance systems can be found in *Dengue and Dengue Hemorrhagic Fever in the Americas: Guidelines for Prevention and Control*, published by PAHO (1994, www.paho.org/English/HCP/HCT/VBD/arias-dengue.htm). These guidelines recommend that disease surveillance be an active system that uses both laboratory and clinical dengue surveillance activities to provide early and precise information to health officials. An active surveillance system

includes sentinel clinics, monitoring of cases of fever of undiagnosed origin, confirmation of cases by laboratory tests, and ongoing analysis of trends of reported cases. To date, few MOH dengue surveillance systems include both active and passive surveillance.

DF/DHF surveillance is challenging since both clinical and entomological data are necessary to determine what actions are appropriate for the situation. For those individuals with technical training in one field or the other (either epidemiology or vector control), triangulation of the data can be challenging. In reality, actions are often taken in isolation, with vector control staff using data obtained through entomological surveillance and the health services sector responding to the clinical surveillance data. This results in delayed response to emerging epidemic trends, inappropriate use of control methods (e.g., reliance on chemicals versus physical or biological control methods), and an unprepared health care system dealing with increases in cases of DF/DHF.

PAHO has recommended the formation of intersectoral dengue commissions at the national, state, municipal, and local levels as one means to facilitate information sharing and to guide dengue prevention and control actions (PAHO, 2001). Although countries may have an intersectoral taskforce or commission, often these groups do not meet unless there is a dengue epidemic. Individual countries will need to analyze current epidemiological and entomological reporting mechanisms and identify ways in which information can be used rapidly across sectors for decision making.

II. Advocacy and implementation of intersectoral actions between health, environment, and education as well as other sectors such as industry and commerce, tourism, legislation, and judiciary

A major obstacle to effective implementation of comprehensive, integrated dengue prevention and control has been the inability of MOHs to mobilize and coordinate sufficient resources needed to sustain behavior change among the target populations and resolve structural issues that result in larval habitats. Dengue is not, and cannot be, the sole responsibility of the MOH simply because containers found in and around the home may be present for reasons over which the MOH has no responsibility or control. For example, water storage may be necessary if piped water is not available, not consistent, or the quality is poor; piles of discarded items may be found on premises or in informal dumping areas if households and businesses do not have access to routine trash collection services; and tires may be found on premises or in informal dumping areas even when regular trash collection exists, because they are generally not collected (tires cannot be placed in landfills, and there are few facilities to incinerate or recycle them). While these environmental or contextual barriers are not within the purview of an MOH, vector control staff must address them on a daily basis.

Ministries responsible for tourism and the environment are natural partners for DF/DHF control programs given the impact of a DF/DHF epidemic on those industries. Tourism can be severely impacted by a large epidemic, especially if

deaths due to DHF are reported; this may cause tourists to change their plans out of fear of contracting the disease. During an epidemic, hotels may incur high costs to spray the surrounding area to keep the adult mosquito population down, and shortages in staff due to illness may affect tourist-dependent businesses, both in levels of service provided and tourists' perceptions of the quality of service.

In addition, advocacy and intersectoral actions at the local level may help municipal and state health departments manage a broad-based program over time because of intersectoral participation from schools, businesses, churches, service organizations, social clubs, and other groups.

III. Effective community participation

As research on human behavior has expanded and more has been learned about what motivates behavior change, the need for an integrated approach that includes physical management of containers, use of chemical and biological control methods and improved environmental management at the individual and community levels, and education to recognize DHF signs and symptoms has become abundantly clear. Given that the mosquito vector lives in and around the domestic setting, laying her eggs in water-holding containers that residents have created, an understanding of the specific behaviors that lead to mosquito production must be developed.

The lack of even the most basic formative research for any community-related activity has resulted in the ongoing promotion of control methods that are either irrelevant and impossible to sustain or ineffective in preventing mosquito production. Most MOHs lack personnel who have the necessary experience to develop behaviors that would be more responsive to the reality of the community setting, and there is little funding for targeted operational research. Traditionally, dengue control programs have not used behavioral outcomes to measure the impact of program activities at the household/individual level. In the case of vector control activities, general entomological indices, such as the house, Breteau, and container, are used to determine whether homeowners are implementing mosquito prevention actions for containers found in and around the home. Since these indices are based on the presence of one or more larvae in a container, with no distinction between large or small numbers of larvae in the container, the indices are not sensitive enough to reflect implementation of the recommended behavior. For example, a common message is that householders should empty the water from containers when they see larvae in the water. Although a householder may routinely inspect and empty the water from containers that have larvae, vector control staff conducting a house visit have continued to identify a small number of larvae in the early stages of development, which can be hard to see. This household would then be classified as a positive house, although the reality is that once the larvae are large enough to be easily seen, the householder will empty the water. Creating a composite indicator that incorporates several behavioral elements (e.g., cleanliness of water, number of larvae, stage of larval development [instar], presence of other positive containers) should allow for a more accurate assessment of actual behavior change.

Community participation is an essential component of education activities to encourage individuals and families to seek prompt medical care when dengue is detected in a community, especially if cases of DHF are detected. Community participation in outreach to neighbors, work colleagues, and members of social clubs can reinforce messages disseminated through the mass media regarding symptoms of DHF and appropriate home-based care of cases of dengue fever (e.g., avoidance of products containing salicylic acid).

While most programs use various combinations of health education, communication, and social mobilization strategies to carry out dengue prevention and control activities, integration of the strategies to achieve this over the long term have not been part of community-based planning for dengue prevention and control. The lack of appropriate outcome indicators to evaluate behavior changes in any of the elements of a dengue prevention and control program limits the ability of programs to monitor and evaluate effectiveness of the strategies being used. There is an effort underway to more consistently link behavioral outcomes with routine dengue education and communication activities (WHO, 2003). Some of the best practices presented in Section 3 will demonstrate a mix of the above-mentioned strategies, determined by local social, cultural, financial, and political factors.

IV. Environmental management and addressing basic services such as water supply, disposal of used water, solid waste management, and disposal of used tires

Environmental management is the framework that has been proposed for dengue-related vector control activities (PAHO, 1994; WHO, 1997). Environmental management provides a flexible framework through which a wide variety of actions can be undertaken in an integrated and coherent fashion. Numerous surveys have shown that, in the region of the Americas, dengue does not rank high on residents' list of priorities (unless the survey is being conducted during an epidemic) and the threat of DHF is not a sufficient motivator for behavior change (Lloyd, et al., 1994; Rosenbaum, et al., 1995). Those same surveys have revealed, however, that residents are concerned about mosquitoes because of the "pest" factor and those concerns would be sufficient to motivate a certain level of behavior change (Rosenbaum, et al., 1995). Yet most dengue control programs continue to function under the assumption that providing more information will motivate behavior change; to date, this has not occurred in a sustainable fashion.

Placing *Ae. aegypti* control in an environmental management framework allows the program to continue to support and participate in existing popular dengue control activities that may not have a significant impact on *Ae. aegypti*, but can be justified for their impact on other vectors (e.g., community clean-up campaigns). Residents' desire for clean water can facilitate water storage behaviors that are favorable to preventing mosquito breeding. A broader environmental management approach also paves the way for greater intersectoral collaboration through advocacy and reduction in duplication of efforts.

V. Patient care within and outside of the health system

The single most important factor influencing case fatality rates due to DHF and DSS is medical case management. As health care providers become more skilled in caring for patients with DF and DHF, case fatality rates should decline, as has been seen in Southeast Asia. Training of health care professionals at all levels (e.g., from nurses staffing small health posts, to physicians and nurses staffing emergency rooms, to physicians working in private practice) is important not only for appropriate triage and case management, but also for good disease surveillance. The rapid reporting of suspected cases and the submission of blood samples taken at the appropriate times and sent in good condition to the laboratory depend upon trained and informed health care professionals.

It is suspected that the majority of DF cases do not even enter the health care system. Home-based care is the preferred treatment, unless the patient becomes so sick that medical attention must be sought or news of a DF/DHF epidemic causes residents to flood the system. Since the onset of DHF/DSS is very rapid, it is essential that all health care professionals be trained to recognize cases of DHF and initiate appropriate therapy. Correct classification of suspected DF/DHF patients and adequate clinical observation with timely therapeutic actions can positively impact the outcome of the course of illness, as has been seen in Southeast Asia.

Communications and outreach activities are needed to help families understand when medical care should be sought; this has traditionally been accomplished by informing the population of warning signs and symptoms of DHF during an epidemic. Including early detection of DF/DHF at the community level as an activity in local program planning may help to improve patient care and treatment. Health institutions such as hospitals and clinics must then be prepared for an increase in the number of patients and, during an emergency, the management of an influx of very large numbers of patients.

VI. Case reporting (clinical cases, confirmed cases, DHF and deaths due to DHF, circulating serotypes)

Prompt, reliable reporting of suspected and confirmed cases of DF and DHF and deaths due to DHF is the core of any dengue prevention and control program. Dissemination of this information in a timely fashion to intersectoral groups such as a dengue commission can then guide decisions to intensify routine control actions or to implement an emergency response using data rather than responding to political pressure. Clinical surveillance should at minimum be based upon a passive surveillance system, with an active surveillance system, as described earlier, a goal to work toward. A national laboratory service that can perform, at minimum, basic diagnostic tests (e.g., enzyme-linked immunosorbent assay [ELISA]) is required for a surveillance system to be successful. Samples for virus isolation should be sent to reference laboratories, either national or regional, or to a WHO collaborating center (the CDC Dengue Branch in Puerto Rico is a WHO collaborating center).

VII. Incorporation of the subject of dengue and health into formal education systems

School-based education programs are believed to be the single best way to inculcate future generations of homeowners with a sense of responsibility for environmental management. However, few vector control programs have been able to sustain school-based activities due, in part, to academic requirements that have led to a “full” curriculum. One reason for this may be that health staff generally produces *Ae. aegypti*-related activities without placing learning objectives into an education framework that teachers can use unless they have the assistance of vector control staff. Another reason is the fact that most “curricula” address dengue and *Ae. aegypti* control as isolated activities rather than as part of a broader health issue. Development of curricula in partnership with curriculum specialists from the Ministry of Education should go a long way toward increasing acceptance of health curricula by teachers and principals.

VIII. Critical analysis of the use and function of insecticides

Most national dengue prevention and control programs rely on the use of various insecticides to control larval and adult stages of *Ae. aegypti*. Typically, program budgets allocate most funds to staff salaries, the purchase of chemicals, and the purchase of equipment to apply the chemicals. Many government employees are under the impression that community-related activities are free and that residents will gladly donate their time for any variety of MOH-directed community programs. These unrealistic perceptions of the “costs” of the various components continue to result in programs that rely on the use of chemicals given that those purchases account for a significant portion of the budget, leaving little funding available for implementation of other components of the program.

The use of chemicals has an important role and function in a comprehensive, integrated dengue prevention and control program. But how, when, and where each type of chemical is used must be critically evaluated prior to its use, and the norms guiding its use rigorously enforced (see Najera and Zaim, 2002). For example, there are many appropriate uses for larvicides (temephos sand granules is the most commonly used larvicide) in both routine and emergency response *Ae. aegypti* control activities. However, its effectiveness at the community, or operational, level needs to be evaluated for each of the containers currently treated with larvicides so that it is used in the most effective manner, and supplies can be maintained for treating those containers where it is most needed. The same issues apply to space spraying, be it ultra-low volume (ULV), thermal fogging, or aerial application. Given the high costs of purchasing the chemicals and equipment, and the labor costs to apply them, the operational effectiveness of all types of space spraying must be evaluated and guidelines for their appropriate use enforced as a result of those evaluations (see Reiter and Nathan, 2001). A final activity that should be part of chemical control activities is routine monitoring of insecticide susceptibility. Technical assistance on conducting efficacy evaluations, susceptibility tests, and the rational use of

insecticides can be obtained from PAHO, the Centers for Disease Control and Prevention (CDC), and WHO (see Annex 1).

Larval control

The use of larvicides to prevent larval development in water-holding containers is an essential component of the vast majority of national programs in the region of the Americas. At times, however, the use of larvicides has been indiscriminate, with containers of all sizes, from bottle caps lying about the back yard to large water storage containers such as 55-gallon drums and cement tanks, being treated with the chemical. This indiscriminant use of larvicides can lead to larval resistance to the chemical. In some countries, use of the larvicide in domestic water containers used for storing drinking water has also generated homeowner resistance to its use. Program staff in a number of countries readily acknowledges passive resistance to temephos. They relate stories of homeowners who remove the chemical once vector control field workers leave the premises, as well as homeowners who actively resist use of the chemical by prohibiting its placement in water containers (interviews by L.S. Lloyd, unpublished data).

Larvicides are costly, and not available 100% of the time in many countries. Should a cycle be missed due to lack of the larvicide, mosquitoes will continue to reproduce in containers with little intervention from either residents or government vector control staff. The continued application of chemicals by vector control staff also reinforces community perceptions that the government is responsible for all facets of vector control, with little to no responsibility residing with residents. This perception has resulted in limited sustained community involvement in environmental management efforts and community demands for mosquito control methods that may not be effective in the affected area. Both PAHO and WHO have recommended that the use of larvicides be limited to those containers that cannot be adequately managed or permanently eliminated.

Adult control

Studies have shown that space spraying is relatively ineffective as a routine control strategy (Clark et al., 1989; Reiter et al., 1989; Perich et al., 1990) and should be reserved for use only during an emergency. WHO, PAHO, and CDC note that emergency control measures during an epidemic may include the application of insecticides as space sprays to kill adult mosquitoes using portable or truck-mounted machines. However, factors to keep in mind are that the killing effect is transient, with mosquito populations usually recovering within one or two weeks; it is variable in its effectiveness because the aerosol droplets may not penetrate indoors to where adult mosquitoes are resting; and the application procedure is costly. All space spraying methods must be evaluated for field efficacy regardless of whether they are being used for routine or emergency actions. Decisions to use space sprays and the method for application should be made only after these evaluations have been conducted.

IX. Formal health training of professionals and workers both in the medical and social sciences

Education of health care professionals in DF/DHF diagnosis, clinical case management of cases of DF/DHF, and case reporting guidelines are essential to a dengue prevention and control program. Health workers need special training in basic diagnostics for DF/DHF so that patients can be triaged accordingly. Training is needed in communication skills so that all levels of health staff, from vector control field workers to health promotion staff to nurses and physicians, provide consistent and correct information. The end result would be that whenever an individual comes into contact with the health system, staff could take advantage of the opportunity to discuss the seriousness of DF/DHF and appropriate care and treatment, identify mosquito habitats and effective control strategies, and motivate behavior changes.

Training in the social sciences is especially important for the development of control strategies that are effective, congruent with residents' daily living circumstances, and sustainable. This may mean modifying a current recommended method to make it more amenable to adoption or developing a new method. This will require training of program staff in social science principles as well as training of social scientists in DF/DHF prevention and vector control. For example, families that have already experienced cases of dengue in the household may ignore messages encouraging individuals to seek medical care since the dengue case was "successfully" treated at home, that is, the family member recovered and did not suffer more severe disease. Communicating the risk of DHF and how to recognize its symptoms requires a deeper understanding of dengue care and treatment at the household level and health care seeking patterns.

Another example of a deceptively "simple" message commonly seen in educational materials throughout the region is that of covering water storage drums or barrels. The message is so general that it is meaningless and, therefore, impossible to implement. Since many families already cover water storage containers, the message has little relevance to a large segment of the target audience, despite the fact that most do not properly cover containers to prohibit the entry of mosquitoes. Correcting this situation requires an understanding of behavior change theories, ways to develop effective mosquito control methods with community input and active participation, and an ability to communicate specific messages related to treatment seeking.

X. Emergency preparedness, establishing mechanisms, and plans to face outbreaks and epidemics

Emergency response is a short-term response to epidemic situations. Emergency actions are intended to be intense, short-term activities that rapidly reduce the adult mosquito population as a means to reduce transmission of the virus. Other emergency actions include case triage and hospitalization policies. Given that DF is an epidemic disease, each country should have an emergency response plan as part of its comprehensive, integrated dengue prevention and control program. Technical assistance in developing a plan can be obtained from PAHO, WHO, and CDC (see

Annex 1). Unfortunately, political support for dengue programs oftentimes reflects an emergency response; that is, attention and resources are provided when the country is in the middle of an epidemic, but such support disappears once the epidemic has ended. Although countries may have an emergency plan, they may not be well prepared to implement it given that routine actions are already limited. This lack of preparedness can severely impair an effective response during an epidemic.

The elements that should be included in an emergency response plan are well described in the PAHO dengue guidelines (PAHO, 1994):

- Form an emergency committee with members from various departments of the MOH and those governmental and nongovernmental agencies that may be involved with some aspect of the emergency response; this emergency committee may be a subcommittee of the dengue commission. All members should understand their roles and responsibilities during an emergency period.
- Provide a consistent and reliable flow of information to governmental agencies and the population once an emergency has been declared; information should be disseminated to the general population instructing residents on emergency actions and appropriate use of health care services.
- Plan for triage of patients; establishment of additional beds for both in- and out-patient care; and sufficient supplies of rehydration fluids, blood products, hematocrits, and other medical supplies and equipment.
- Focus emergency vector control actions on the rapid reduction of adult mosquitoes initially through space spraying, although larviciding and source reduction activities should also be intensified since epidemics last for several weeks or months. While no studies have shown that space spraying effectively interrupts an epidemic, control methods that reduce the number of potentially infected mosquitoes should be considered during an emergency.
- Evaluate impact of emergency response actions on disease transmission, clinical case management of suspected cases of DF/DHF, and mosquito control.

3. Examples of Best Practices

Examples of best practices for each of the 10 elements of the Decalogue were solicited from individuals knowledgeable about dengue prevention and control programs in the Americas (results are presented in Table 2). An example was selected if the practice had been expanded beyond a pilot phase (with the exception of DengueNet) as a result of demonstrated effectiveness and had some reported level of sustainability. The best practices for case definitions, clinical case management, and laboratory diagnostics reflect the cumulative experience of individuals working in those fields for many years, resulting in standards being set by WHO, PAHO, and CDC. Individuals involved in the development and/or implementation of the practice were then contacted and asked to contribute a five-page description of the best practice, the process used to develop the practice, where appropriate, and evidence that the practice was effective and being sustained.

Table 2. List of Best Practices for the 10 Elements of a Comprehensive, Integrated Dengue Prevention and Control Program

Essential Program Element	Best Practice
1. Integrated epidemiological and entomological surveillance	1. DengueNet – a global dengue surveillance system, WHO 2. Weekly Epidemiological Report produced by the Venezuelan Ministry of Health and Social Development 3. Role of the Dengue Diagnostic Laboratory, CDC Dengue Branch, Puerto Rico
2. Advocacy and implementation of intersectoral activities	1. No best practice included for advocacy 2. No best practice for intersectoral activities identified
3. Effective community participation	Social mobilization of city residents for dengue control, Brazil Community participation elements in the practices from Brazil, Mexico, and Dominican Republic
4. Environmental management and addressing basic services	1. Use of the key container and key premise indices for surveillance and vector control actions, Vietnam 2. Management and control of tires found in the domestic setting, Mexico 3. Management and control of 55-gallon drums used for water storage, Dominican Republic
5. Patient care	Clinical case management protocols, CDC Dengue Branch, Puerto Rico
6. Case reporting	Case definitions for DF, DHF, and DSS, CDC Dengue Branch, Puerto Rico
7. Incorporation of dengue/health into formal education system	“Reducing Pests and Insect Vectors” curriculum developed for primary schools, English-speaking Caribbean, CPC/PAHO
8. Critical analysis of the use and function of insecticides	No best practice identified
9. Formal health training of professionals	Development of the environmental health technician position and training program, Honduras
10. Emergency preparedness	No best practice identified

While a best practice specifically addressing broad-based community participation was not received, community participation was addressed in the best practices from Brazil, Mexico, and the Dominican Republic. Community participation was key to the successful development and adoption of appropriate *Ae. aegypti* control methods for tires and water storage drums. And in Brazil, the social mobilization campaign was successful in motivating residents to participate in a day of special dengue clean-up activities. These best practices provide examples of how to invite community

participation in the development of control methods and sustain that motivation through implementation.

3.1. Global Dengue Surveillance—DengueNet

Contributed by: Ray Arthur, Ph.D., and Renu Dayal Drager, Ph.D., WHO

Why was this practice selected?

Given the central role of disease surveillance data for cases of DF and DHF and laboratory surveillance for prompt identification of circulating serotypes, global information on cases of dengue and circulating serotypes that is easily accessible to WHO member states is critical for program planning and decision making. This type of global information is available through DengueNet. Should countries in the same region experience an epidemic, neighboring countries will be able to track the number of cases and deaths and prepare for a potential emergency response depending upon the serotype circulating.

Although DengueNet is currently used for historical data analysis, it is still under development and is in the process of being field tested in several countries in the Americas. Results of the field test will help refine the DengueNet system as it is expanded to other WHO regions.

What is the best practice?

The best practice is the development of a system that tracks DF/DHF cases and circulating serotypes across the globe so that countries can better assess their risk of an epidemic in light of regional and subregional dengue activity. WHO's Internet-based System for the Global Surveillance of Dengue Fever and Dengue Hemorrhagic Fever (<http://www.who.int/denguenet>) will provide up-to-date (real-time) data to all member states affected by dengue and DHF.

WHO has created DengueNet as a central data management system to do the following:

- Collect and analyze standardized epidemiological and virological data in a timely manner and present epidemiological trends, as soon as new data are entered
- Display in real-time important indicators such as incidence data, case fatality rates (CFR) for DHF, frequency and distribution of dengue and DHF cases, number of deaths, and distribution of circulating dengue virus serotypes
- Provide both historical and real-time data.

The DengueNet system¹ responds to the WHO resolution on DF/DHF prevention and control (http://www.who.int/gb/EB_WHA/PDF/WHA55/ewha5517.pdf) adopted at

¹ DengueNet has been developed in collaboration with the WHO Collaborating Center for Electronic Disease Surveillance at the Institute Nationale de la Santé et de la Recherche Médicale, INSERM Paris, France.

the 55th World Health Assembly in May 2002, asking member states “to build and strengthen the capacity of health systems for surveillance, prevention, control and management of dengue and DHF,” and emphasizes the critical importance of strengthening laboratory diagnosis in affected countries. It is in line with the principles PAHO developed for epidemiological and laboratory surveillance of dengue and DHF in the Americas as outlined in the Resolution CD43.R4 (www.paho.org/english/gov/cd/cd43.r4-e.pdf) and the Working Document CD43/12 adopted by the PAHO Directive Council in September 2001 (http://www.paho.org/english/gov/cd/cd43_12-e.pdf).

The main features of this Internet-based surveillance tool include the following:

- Password-protected capability for remote data entry by all DengueNet partners worldwide, with data updated on a real-time basis
- State/province subdivision levels of the countries for which data will be entered and indicators such as incidence calculated
- Dynamic query facility with analysis and presentation of data in graphic, tabular, map, and free-text formats
- Use of geographic information system (GIS) tools to provide real-time map of the epidemiological situation
- Links to the dengue web pages of WHO offices, countries, collaborating centers, and research and medical institutions working worldwide on DF/DHF prevention and control
- Provision of an up-to-date directory of national and international partners in the DengueNet network
- Dengue news, information, and document center.

Currently, global dengue statistics from 1955 to 2001 can be accessed on DengueNet. As countries begin entering data into DengueNet, real-time updates of standardized epidemiological and virological data will become available. When DengueNet is fully implemented, public health authorities and the general public will have immediate access to epidemiological data on dengue, DHF cases and deaths based on standardized case definitions, and virological data on the circulating dengue virus serotypes (dengue virus -1, -2, -3 and -4) that national health officials have entered directly into the DengueNet database via the Internet.

A key objective is to ensure that data of the highest possible quality are reported in a timely manner to DengueNet. This may be achieved by standards for surveillance, laboratory procedures, and quality control that are supported by a strong partnership between the network partners involved including the national programs, WHO collaborating centers, and WHO country, regional, and global levels.

Describe the process to develop the practice

Since DengueNet already exists as a historical database, the process to determine how to implement a global epidemiological and virological surveillance system involved a meeting with stakeholders and the establishment of working groups. The first meeting on DengueNet implementation was held July 9-11, 2002, in Puerto Rico². The specific objective was to launch pilot testing by building on the existing reporting systems and network of dengue laboratories in the Americas.

Purpose and objective

Forty participants (surveillance epidemiologists and laboratory specialists) from 15 countries participated in this first meeting. The overall objective was to describe and demonstrate DengueNet to prospective users and to develop a framework for DengueNet implementation with emphasis placed on quality of data and active participation of national programs. The focus of the technical discussions in the plenary was the challenge and need for global epidemiological and laboratory surveillance of dengue and DHF; the national epidemiology and laboratory capacities in participating countries in the Americas; and presentation of DengueNet and a “hands-on” session with the Internet site. Two working groups were convened. The first defined the epidemiological data and reporting requirements for DengueNet, modifications needed to its present format, identification of countries for pilot testing, and roles and responsibilities of national and international partners. The second group reviewed laboratory standards and quality control issues for dengue serological diagnosis and virus isolation building on the recommendations of the two previous WHO meetings on dengue laboratories in the Americas.

² This meeting was jointly organized by the WHO Department of Communicable Disease Surveillance and Response, Global Alert and Response, the PAHO Division of Communicable Disease Prevention and Control, and the WHO Collaborating Center for Dengue Reference and Research at the Dengue Branch, Division of Vector-Borne Infectious Diseases, U.S. Centers for Disease Control and Prevention. Participants included: National programs from Brazil, El Salvador, French Guyana, Guatemala, Nicaragua, Mexico, Puerto Rico/United States, Venezuela; CAREC (Trinidad), the subregional surveillance network for 20 island countries in the Americas; WHO collaborating centers and research institutions in Argentina, Brazil, Cuba, Canada, United States; participants from Indonesia, Thailand, and Vietnam that will assist WHO in organizing a DengueNet meeting in 2003 for high burden countries in Southeast Asia and the Western Pacific; and WHO HQ, PAHO, and WHO/PAHO country offices in Brazil and Nicaragua.

Meeting outcomes

This first meeting marked the start of the phased implementation of DengueNet with the Americas starting in 2002 and the Southeast Asian and Western Pacific regions in 2003. The key outcomes of these discussions are summarized in the following paragraphs.

Data collection

Epidemiological data: Countries will provide these data by epidemiological week at the state/department level for the large countries and at the island level for island countries. The data reported in DengueNet will include the clinical categories of DF and DHF, both suspected and confirmed cases, and only confirmed dengue and DHF deaths. Case fatality rate will be calculated as follows:

$$\text{CFR} = \text{Confirmed Deaths/Confirmed cases of DHF}$$

Virus serotype data—all available: These data will be provided for the entire country and will be displayed in DengueNet as the number of isolations of each serotype in the country for the time period for which these data are provided. DengueNet will calculate the proportion of the total number of isolations of each serotype as a percentage of total number of isolations of all four serotypes isolated in the country for the time period for which they are provided.

General considerations

Only the central level of each country will provide data (one source of data per country). DengueNet will link to the country web pages for additional information. The data entered during the pilot testing period will include a disclaimer stating that the system is being tested and that the data for this period are provisional.

Roles and responsibilities of the partners in this network

Countries will collect, validate, and provide epidemiological and laboratory data, and they will designate the participating centers. The WHO collaborating centers will continue to provide laboratory support, proficiency panels, and training to national laboratories. PAHO will support the country implementation activities and WHO headquarters (HQ) will maintain and moderate the DengueNet website. Both PAHO and WHO/HQ will seek financial support for dengue surveillance activities.

Country participation

A major outcome of the meeting was that all the representatives of countries in the Americas expressed interest in participating in the DengueNet pilot test, and the representatives of Southeast Asian countries indicated interest in having the system expanded to include their region. The participants will follow up with their country authorities to obtain official authorization to participate in DengueNet. WHO country

representatives will support the participants in presenting the DengueNet proposal to the country authorities. The pilot testing of DengueNet in the Americas will be conducted over a three- to six-month period. The lessons learned will be built into the implementation framework for high burden countries in the Southeast Asian and Western Pacific regions in 2003.

What did not work?

Pilot test data in six months should provide this information.

Sustainability

DengueNet is being pilot tested and should be phased into three of the WHO regions over the next 18 months. Pilot test data should provide a better indication of how the data are being used. The TDR Scientific Working Group on Dengue, in its recommendations of the April 2000 meeting, “strongly endorses the establishment of DengueNet (a web-based surveillance initiative within the CDS Communicable Disease Surveillance and Response—CSR—Department) and encourages the exchange of information of dengue viral serotypes and genotypes. These data should be monitored for utility as an epidemic prediction tool. Special attention needs to be paid to surveillance efforts along national borders.” Statements made by member states during the 2002 EB 109—109th session of the Executive Board (the secretariat to the WHA, which meets twice a year)—and the 55th World Health Assembly adoption of the draft resolution on dengue/DHF prevention and control also included the need for a sustainable global surveillance system accessible to all member states. At the first meeting on DengueNet implementation in July 2002, representatives of all participating countries from the Americas expressed interest in participating in the pilot test of DengueNet and the representatives of countries from Southeast Asia and the Western Pacific expressed interest in having DengueNet pilot test expanded to include their countries.

Evidence that the practice works

DengueNet will provide national and international public health authorities with epidemiological and virological information by place and time that can guide public health prevention and control actions. Being able to monitor virus transmission and circulating serotypes by place and time during inter-epidemic periods will be useful for early warning of dengue activity in neighboring states/countries, and will provide time for planning increased *Ae. aegypti* control strategies. This is particularly important in the region of the Americas characterized by unstable dengue epidemic activity with emerging DHF cases.

The system also provides information on CFR by place and time, and this can be used to effectively target training in countries and regions that need to improve hospital-based DHF case management to reduce CFR. This is particularly important where all four dengue viruses are endemic, DHF cases occur year after year, and the CFR is

used to monitor progress in hospital case management and public education campaigns.

In addition, DengueNet contains valuable historical and current data that may be useful for public health researchers to support their research and that national and international agencies could use for advocacy purposes.

Key points to remember

Key Point	Relative Importance*	Why?
Password protected capability for remote data entry in a standard format into DengueNet via the Internet directly by national health officials	Critical	Permits timely collection and analysis of standardized (comparable) epidemiological and virological data from affected countries worldwide.
Dynamic query facility and use of GIS tools for analysis and display of data in graphic, tabular, map, and free text formats.	Critical	Provides national and international public health authorities with epidemiological and virological information by place and time that can guide public health prevention and control actions.
Collects and displays frequency and distribution of dengue and DHF cases and number of deaths, and calculates important indicators such as incidence data, and CFR for DHF as soon as new data are entered.	Very important	Information on CFR by place and time can be used to target training to countries and regions that need to improve the hospital-based DHF case management to reduce CFR and to monitor progress made in hospital case management and in public education campaigns.
Collects and displays frequency and distribution of virus isolates of Den - 1, -2, -3, -4 serotypes by place and time	Very important	Monitoring of virus transmission and circulating serotypes in the inter-epidemic periods will be a useful early warning of dengue and DHF activity in neighboring states/countries to plan dengue prevention and control strategies.
Internet-based central data management system with data on dengue cases and deaths reported to WHO since 1955	Very important	Provides unrestricted access to historical and real-time data that are useful for public health programs, research, and advocacy
Links to the dengue web pages of WHO offices, countries, collaborating centers, and research and medical institutions working worldwide on dengue and DHF prevention and control	Important	Provides an entry point to an up-to-date directory of national and international partners in the DengueNet network and dengue news, information, and documents center.

* critical, very important, important, not critical but very helpful

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3.2. Weekly Epidemiological Report

Summary prepared by: Linda Lloyd, Dr.P.H. for Venezuela

Why was this practice selected?

Most countries have an epidemiological surveillance system that mandates the reporting of suspected cases of DF and DHF and deaths due to the disease. Most countries also produce an epidemiological report for distribution throughout the MOH, although the periodicity of issuing the report may not always be consistent. A major challenge to epidemiological surveillance systems in most countries is the reliable, rapid transmission of data from local areas to the central level.

The weekly epidemiological report produced by the Department of Epidemiology of the Venezuelan Ministry of Health and Social Development (MSDS) was selected because clinical data are analyzed and presented in user-friendly graphics and descriptive text to help staff make appropriate decisions regarding dengue control. In addition, entomological data are included during reporting periods when dengue activity has increased. The entomological data can be triangulated with the epidemiological data since data are reported at the state level. There is also the potential to use the data for advocacy in areas that may be experiencing increasing numbers of cases of DF/DHF since the weekly report is easily accessible via the Ministry's website. The weekly epidemiological report includes a high level of analysis for epidemiological and, when included, entomological data using tables, graphs, and text to succinctly summarize the data.

What is the practice?

The MSDS, Department of Epidemiology, has developed a comprehensive weekly epidemiological report (ALERT, Weekly Epidemiological Report for Management/*ALERTA, Reporte Epidemiológico Semanal para el Nivel Gerencial*) that is delivered via e-mail to health departments and health centers throughout the country and is also accessible via the Ministry website (<http://www.msds.gov.ve>). The weekly report includes colored tables, maps, graphs, trends, and explanatory text to help health staff make appropriate decisions regarding the control of reportable diseases, including DF/DHF. Both suspected and confirmed cases are reported since in dengue endemic countries it is important to report suspected cases based upon a clinical diagnosis; reporting only laboratory confirmed cases will mask the actual level of dengue transmission, particularly during epidemics.

Epidemiological information is an essential component for the proper planning and evaluation of health services. To determine the type of action needed for dengue prevention and control, varied information is required: quantitative data on the number of reported cases, the number of laboratory-confirmed cases, the number of deaths due to DHF, circulating serotypes, prevalence rates for *Ae. aegypti* breeding sites (commonly the container index—the percentage of water-holding containers

positive for *Ae. aegypti* larvae or pupae—and the Breteau index—the number of positive containers per 100 houses inspected), and the prevalence of houses or premises positive for at least one container with *Ae. aegypti* larvae (house index—percentage of houses with at least one positive container for *Ae. aegypti*). This is necessary whether the action is routine or an emergency response.

Therefore, the weekly epidemiological report provides systematic, opportune, and informative data that can be used to make practical administrative decisions. Health staff in managerial positions need data that will help them to make these decisions in a timely fashion, often within the context of limited resources and competing demands on those resources. The report is sent via e-mail as an Excel spreadsheet programmed with the relevant formulas and parameters. As data are entered, the corresponding tables and graphs are automatically updated (reported to L.S. Lloyd by a recipient of the weekly report). For individuals accessing the report on the MSDS website, the report is downloaded as an Acrobat Reader file.

Format of ALERT, weekly epidemiological report for management

The use of color helps to highlight differences and draw attention to areas of concern, thereby making the data available in this report user friendly. Health staff in areas with increased dengue activity can quickly assess the data and determine whether immediate emergency actions are needed or control actions should be reinforced.

1. Disease surveillance

For example, a standard table reporting the number of DF and DHF cases and deaths for the epidemiological week and the number accumulated through the previous week includes data for the same period from the previous year. This allows staff to determine whether the number of reported cases is higher, the same, or lower in comparison with the previous year. A second table, however, lists each state (the primary political division) and the number of cases of dengue across the current epidemiological week as well as the 10 prior weeks, with the final column summarizing the trend as “increasing,” “decreasing,” or “the same.” This allows staff in each health department to quickly determine whether the dengue case trend is increasing or at the same level as the previous weeks without having to make any calculations. The state or local epidemiologist can assess trends in neighboring regions as well, and determine whether there is a regional issue to be addressed, increasing numbers of cases in a neighboring state warrant special attention, or the numbers are within the normal range.

According to Rigau-Pérez, et al. (1999), during routine surveillance it is common to see short-term increases in disease reporting from a locality that does not necessarily indicate the start of an outbreak. The surveillance system must be able to differentiate transient and seasonal increases in disease incidence from increases seen at the beginning of an outbreak. These situations can be differentiated by the use of statistical and laboratory indicators. The comparison of previous years’ data for the

numbers of reported cases is one simple approach (e.g., the standard table described above).

However, this does not take into account expected variability. A more appropriate procedure for comparison would be to use as baseline the average number of reports for a period and to set the confidence interval (CI) limits at plus or minus two standard deviations from the average. A graph of such averages by week (the índice endémico or canal endémico [endemic index or endemic channel]) is often used in Latin American countries in weekly epidemiological reports to compare the current activity of the disease to its historical average (Fayad Camel, 1970). To obtain a more accurate idea of the seasonal distribution, some countries eliminate the largest epidemic year as well as the year with very low transmission. For example, the CDC Dengue Branch produces a graphic report of dengue activity in each municipality in Puerto Rico with mean numbers of cases from 1991–1993 and 1995–1996 as the historical averages (Rigau-Pérez, et al., 1999). Panama also publishes a weekly endemic channel, using the number of cases from 1997–2001 as the historic average. In the case of Venezuela (graph 1), the endemic channel compares the current number of reported cases with the average number of cases from 1994–2000. Using two standard deviations as the range within which the number of cases will fluctuate, the graph clearly depicts when the number of cases is above what might be considered normal for that period. This information should initiate an investigation to see if other areas are also experiencing increases and it should warrant an examination of entomological surveillance data.

2. Entomological surveillance

Following the presentation of the epidemiological data, entomological data are included during times of increased dengue activity. Graphs are used to compare the house index for the same time period the prior year, and include a paragraph explaining the number of localities that have been inspected and the actions (use of larvicide, elimination of container) taken for “permanent” and “not permanent” containers. Another chart specifies the breeding sites by type (specific container index) so that the containers most frequently found to be positive are highlighted. For example, graph 2 (for epidemiological week 32) includes the prevalence of containers positive for *Ae. aegypti* the current year compared to the previous year for tanks, drums, tires, flower pots, and other. Since the explanatory text reports the prevalence along with the 95% CI by type of container, staff can determine where to focus control activities.

A summary list of actions to be taken as well as reminder messages are included. These may include reminding staff of the importance of disease surveillance (accurate and timely reporting) and appropriate use of laboratory services (when to send a blood sample and the time period to take paired samples). Because physicians move frequently within the health system, these reminder messages may help less experienced staff identify next steps, collaborative relationships that need to be established, and actions that need to be taken for emergency response preparedness, among others.

3. State-by-state analysis

The last set of graphs and analyses includes two maps of the country that compare the current epidemiological week with the previous week, with the regions colored according to their status (“Stable,” “Alarm,” “Epidemic”). Underneath the maps is a table that presents the data by region, with information regarding the percent of total cases the region accounts for, the percent increase or decrease from the previous week, and the percent of regional sites reporting. The table also provides a column with an arrow that shows whether the number of cases is increasing, decreasing, or stable. This table provides regional information that consolidates data from several states and yet allows each state health department to see how their reporting system is functioning compared with other states. These data allow epidemiologists at the central, state, and local levels to evaluate why some reporting sites with documented DF/DHF cases are not reporting cases and develop strategies to improve reporting from those sites.

Describe the process to develop the practice

The process to develop the practice is not known because an MSDS staff person did not prepare this example. A key question that will need to be answered for any country thinking about placing its weekly epidemiological report on the MOH website would be what resources are required to set up and maintain the web-based report format.

What did not work?

This question cannot be fully addressed because an MSDS staff person did not prepare the best practice. However, an assessment of the technology and staff commitment to maintain such a sophisticated reporting system should be conducted before launching a web-based reporting system. Although placing the report on the MSDS website is an excellent idea and will increase access to information, the overall costs for ensuring that state health departments and municipal health centers have sufficient capacity to reliably access the Internet should also be taken into account. Other issues of importance to this example include the time lapse between receipt of the data and posting on the site.

Sustainability

Sustainability is assumed given that the website is that of the Ministry of Health and Social Development. The weekly ALERT was published on paper for years prior to the website format, and it is a central part of the routine activities of an MOH. Accessibility of the information should be widespread for those health centers and individuals that have access to the Internet. The MSDS also e-mails the information to individuals, and individuals can request that information by sending an e-mail to the contact information below. Information regarding whether the Ministry also mails the report was not available.

Key points to remember

Key Point	Relative Importance*	Why?
Ease of access	Critical	Epidemiological and entomological data are essential to decision making.
Timeliness	Critical	Decisions must be made using real-time data, especially in a pre-outbreak period.
User-friendly	Very important	People will use the document for decision making if they understand the data being presented.
Visual	Very important	Easy, fast, and accurate visualization of dengue and <i>dengue trends</i> are critical for a good understanding of the situation as well as facilitating quick action in control actions.

* critical, very important, important, not critical but very helpful

References

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- Rigau-Pérez, J.G. et al. (1999) A deviation bar chart for detecting dengue outbreaks in Puerto Rico. *Am J Public Health*, 89:374-8.

Contact for additional information

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3.3. Dengue Diagnostic Laboratory

Contributed by: Vance Vorndam, Ph.D., CDC Dengue Laboratories, Puerto Rico

Why was this practice selected?

Laboratory-based surveillance is an essential component of a dengue control program. Without laboratory capacity, a country will be unable to detect the presence of circulating dengue viruses, and therefore vector control programs will not be effective in controlling the mosquito vector. The CDC Dengue Branch is a WHO collaborating center for dengue, and serves as a reference laboratory for the region. The CDC dengue laboratory provides diagnostic laboratory services, training of laboratory staff from throughout the region either at the laboratory located in Puerto Rico or through in-country training, provision of dengue reagents to qualified laboratories in the region, and quality control by sending proficiency test kits periodically to each national laboratory.

What is the best practice?

The establishment of a dengue diagnostic laboratory is essential to detect the introduction of dengue into an area, or to detect a rise in the number of cases as a warning of the onset of an epidemic. Given the current lack of a vaccine and the general failure of mosquito control measures, management of DF/DHF depends upon good clinical diagnosis, with the dengue diagnostic laboratory providing support services for confirmation. With this information, public health authorities can institute control measures.

Diagnostic tests

The most important test a dengue diagnostic laboratory can offer is the detection of IgM antibodies. This test is normally performed using an ELISA, and is now available commercially in kit form. Unfortunately, the cost of kits can be impractical for many countries, and the quality of the kits may vary between manufacturers and over time. ***The U.S. Food and Drug Administration has not approved any of the kits.***

Alternatively, reagents and supplies required for the ELISA test can be purchased or prepared by central laboratories. The most difficult reagent to obtain is antigen (purified, inactivated dengue virus) since production of this component requires either tissue culture capability or a mouse colony. The other critical component, enzyme conjugate, is supplied by the CDC Dengue Branch to qualifying laboratories (contact CDC for further information). Once the ELISA test for dengue is established, any laboratory that performs ELISAs for other diseases can perform this test. The detection of IgG antibodies by an ELISA is also useful under some circumstances, but is less important than the IgM test, as IgG antibodies persist in the blood for many years.

The next step in developing a dengue diagnostic laboratory is the ability of the laboratory to isolate virus in the blood of acutely ill patients. Historically this has been done by inoculation of tissue culture, and it requires a laboratory with this capability. This procedure is considered to be the gold standard for identifying the serotype of dengue virus being transmitted, and offers the advantage that isolates can be archived for additional studies. In recent years polymerase chain reaction (PCR) has become popular as a rapid test, particularly in laboratories that do not have tissue culture facilities. Disadvantages of PCR are that some of the components are expensive and labile, and the test is technically complex and susceptible to false reactions. It is recommended that laboratories employing PCR for virus diagnosis have adequate quality control procedures and confirm some percentage of positive tests using tissue culture isolation in a reference laboratory.

Describe the process to develop the practice

The basic dengue diagnostic laboratory is designed around the following factors:

After a person has been bitten by an infected mosquito, an incubation period of three to seven days is usual before symptoms appear. The virus circulates in the blood during this time and up to five days after the onset of symptoms. During this period the virus may be detected in serum samples. By the sixth day after the onset of symptoms, antibodies against dengue virus have appeared and can be detected. The most important of these is IgM antibody, as it persists in the blood for only two to three months and is thus a good marker for recent infection. IgG antibodies are also produced, but these circulate in the blood for many years and are generally useful only if paired acute and convalescent phase samples are available to observe a change in antibody levels. Hence, the ELISA test is a key test for any dengue diagnostic laboratory.

Surveillance systems for dengue virus transmission are most successfully developed around a collaborative arrangement between a central laboratory and a limited number of sentinel clinics or hospitals, located primarily in population centers around the country. An important factor is that participating doctors be educated as to the function of a surveillance system and be encouraged to submit samples from febrile patients throughout the year, even when dengue transmission is not noticeable. By this means the initial rise in cases at the beginning of an epidemic can be detected. It is equally important that the laboratory return test results to the doctors within a limited time frame, so that interest in the program is maintained. Successful surveillance systems tend to grow as other doctors and clinics offer to participate.

What did not work?

What does not work in this practice is using laboratory results to determine a course of treatment for an ill patient, principally because of the limitations of the tests. For patients that are acutely ill, the primary test is virus isolation. However, this generally requires a week of incubation before results are available. As with antibody tests, some patients will not develop detectable amounts of anti-dengue antibody until

a week after onset of symptoms. For these reasons, patients should be treated symptomatically without waiting for laboratory results.

Once a dengue epidemic has been declared, continued processing of large numbers of samples from the epidemic area is not recommended if national laboratory resources are limited. Samples from critically ill patients, however, should be processed immediately. Unfortunately, physicians and governmental officials often pressure laboratories to process all samples received. This may result in long delays in processing samples and reporting the results back to the physician or health entity, as well as drain limited resources from the laboratory system.

Sustainability

Most areas of the world have regional reference laboratories designated by WHO, and the CDC Dengue Branch is one of these. The CDC laboratory in Puerto Rico was established in the 1950s, and in 1963 became an official CDC field station to study malaria and schistosomiasis. In 1973, the emphasis of the laboratory was shifted to dengue surveillance and to providing dengue diagnostic services to countries in the region. The CDC Dengue Branch is funded by the U.S. government, with some funding from WHO. The CDC Dengue Branch does not charge for diagnostic services or reagents provided to government laboratories.

The purpose of WHO regional reference laboratories is to support national diagnostic laboratories, which in turn support local laboratory networks. The regional reference laboratories can provide consultations and training for national laboratories seeking to establish or expand dengue surveillance programs. They also can supply a reference amount of reagents to calibrate locally produced products and proficiency testing kits for quality control of laboratory capacity.

Key points to remember

Key Point	Relative Importance*	Why?
Sufficient stock of reagents for ELISA tests	Critical	The ELISA is the basic laboratory diagnostic test for dengue, and a lack of reagents can impede timely identification of dengue cases in an area.
A surveillance system consisting of the central laboratory and a limited number of sentinel clinics or hospitals, located in population centers around the country	Critical	To identify dengue virus circulation throughout the country.

* critical, very important, important, not critical but very helpful

Contact for additional information

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3.4. Social Mobilization of City Residents in Dengue Control

Contributed by: Helena Celia Ribeiro Montiani and Cristina Gutemberg Lima Silva, Brazil

Why was this practice selected?

Social mobilization, a process to obtain and maintain the involvement of various groups and sectors of the community in the control of disease and/or its vector (UNICEF & WHO, 2000), has traditionally been used to engender community participation in broad-based dengue prevention and control activities such as community clean-up campaigns, demands for governmental attention to environmental problems, and school-based action to mobilize parental involvement in maintaining the school premises.

This practice was selected because of the involvement across governmental entities (e.g., federal, state, and municipal governments and several ministries), the level of participation of the general population, the geographic area covered by the mobilization activities, and the creative use of multiple communication channels to encourage support of and participation in the mobilization activities that were organized for *D-Day of Rio against Dengue (D-Day)* on March 9, 2002. A significant motivating factor for creating the concept of *D-Day* and developing the mass mobilization activities organized around it was the fact that Rio de Janeiro was experiencing one of the largest dengue epidemics in the country. Rio de Janeiro accounted for the majority of DF and DHF cases in the country: 50% of all DF cases reported, 77% of all DHF cases, and 48% of DHF-related deaths.

What is the best practice?

The best practice is the use of novel communications and mobilization strategies to organize a mass mobilization of city residents to conduct dengue control activities on one specific day, March 9, 2002. This day will be registered in the history of the Brazilian public health system as the date of the first large-scale social mobilization activity carried out in the fight against dengue in Brazil. *D-Day* involved 14 million people in 90 of the 92 municipalities of the state of Rio de Janeiro.

Although they can be significant, field actions using insecticides (chemical control) and dengue field staff to conduct house-to-house inspections will always be insufficient in stemming the proliferation of *Ae. aegypti*. In Brazil, since 90% of the foci of the mosquito are found in and around the house, only the adoption of collective and simultaneous domestic actions for prevention will be able to produce a rapid impact on dengue. This was the premise for *D-Day*.

Describe the process to develop the practice

D-Day, as the action was named, was inspired by the experience of the annual campaign to vaccinate infants. *D-Day* was a massive house-by-house inspection to eliminate or treat any object that could be transformed into an active breeding site of *Ae. aegypti*. This large-scale social mobilization activity depended upon partnerships between governmental entities, most importantly between the various levels of government and other nongovernmental organizations (NGOs).

Partnerships

As Brazil's largest tropical city, Rio de Janeiro, with a population of 5.86 million people, is an ideal habitat for the proliferation of *Ae. aegypti*. The city is warm and humid, has areas of Atlantic rain forest, and suffers from rapid and unplanned urban sprawl. The city's communities are centers of contrast, mixing areas of extreme poverty and wealth so that neighborhoods totally covered by sanitation services often exist beside slums totally lacking in any infrastructure. In addition, some slums are inaccessible to outsiders, those who do not belong to that community, which makes it extremely difficult for public authorities to take any action.

In February 2002, the Fundação Nacional de Saúde (FUNASA), the branch of the MOH responsible for controlling endemic diseases, reinforced the structure of the municipal health departments in the state of Rio de Janeiro by sending the city 324 vehicles, 75 ULV machines for installation on pick-up trucks, 120 ULV portable units, and 94 microscopes. In addition, FUNASA organized hospital medical assistance in the public health system for patients with dengue and created a task force comprised of 2,300 men, consisting of sanitation workers and soldiers from the Army and the Navy. The task force joined with dengue field workers to visit areas of the city and of Baixada Fluminense, a northern suburb of the city—areas that were most affected by cases of DF. The task force and dengue field workers treated or destroyed *Ae. aegypti* foci and educated residents on how to fight against the mosquito. The task force was active until April 2002, during which time task force members visited 1.4 million properties. Although the task force was not organized as part of the large-scale mobilization activity, the task force activities were incorporated into *D-Day*.

Although the MOH has promoted dengue prevention and control campaigns since 1996, March 9, 2002, was established as “point zero” in order to increase general consciousness that combating dengue is everyone's responsibility, including the federal, state (regional), and municipal (local) levels and residents, all of whom must adopt, as part of their domestic routines, basic mosquito prevention and control actions. In order for *D-Day* to take place, the MOH, on behalf of the federal government, requested the support of the state and municipal governments, which then joined in partnerships with private industry and NGOs to mobilize the population.

The campaign

No more than one month passed from the date of conception to the implementation of *D-Day*, a campaign originally planned only for the city of Rio de Janeiro. During this month, the majority of the municipalities of the state of Rio de Janeiro came to embrace the idea and, as a result, the population to be mobilized became three times greater than originally planned. During that one-month period, organizers developed a complex and efficient communication strategy. The target audience, no longer a specific segment, became the entire population of the state of Rio de Janeiro, that is, 14,391,282 people in more than 4.2 million domiciles.

To reach this target, the MOH developed marketing tools using data from the FUNASA technical units. Knowledge about habits and customs of the population, which FUNASA had observed over 20 years of epidemiological surveillance, and the experience of national mobilization and health promotion campaigns developed by the MOH, were very useful in designing the campaign. However, the campaign itself was contracted to a private agency. Over the two weeks leading up to *D-Day*, the campaign was heard everywhere, from the streets to the sky, from the beaches to the workplace to the homes of the “carioca” (natives of Rio de Janeiro). The slogan of the campaign, “Rio is too beautiful to be shut down by one mosquito,” was heard throughout the state through print, electronic, and interpersonal communication channels.

The *D-Day of Rio against Dengue* advertising campaign cost the MOH Reais\$3 million, or nearly US\$1.2 million. Two-thirds of the funds were used to place ads in the mass media: 51.2% in newspapers, 20.3% on radio, 19% on TV, and 9.2% in other print media (billboards, banners, etc). The print and broadcast alternative media also had a significant role in the mobilization campaign. Two weeks before *D-Day*, the alternative media (including newspapers, television, and radio) helped to create a favorable atmosphere for the mobilization and, as March 9th approached, time and space for the *D-Day* campaign increased.

A large volunteer network was established, with more than 1,000 volunteers from NGOs, community associations, the Boy Scouts, and directors of several universities trained to serve as multipliers in the process of disseminating information. The Minister of Health intensified the frequency of visits to Rio de Janeiro, and FUNASA temporarily transferred its headquarters from Brasilia to the city of Rio de Janeiro and moved the great majority of Brazilian specialists in the disease. Combating dengue therefore became a national priority.

The following paragraphs provide more details on how the campaign was implemented.

From the streets to the sky

The city of Rio de Janeiro, the most popular tourist destination in the country, was “dressed” two weeks before *D-Day*, with a “D” logo created for the social

mobilization campaign appearing on bus stops, street signs, traffic lights, and other urban signs. Giant banners covered the front of some of the principal properties of Rio, including the central train station. Volunteers distributed 300,000 flags attached to informational pamphlets about dengue, placing them everywhere: in apartments, shops, newsstands, trailers, vendors' stands, and any place the imagination would allow. The flags were also hung from all poles along the principal avenues of the city.

In addition to hanging flags on street poles, organizers draped banners along the overpasses of the three main avenues of the city, and overhead electronic billboards displayed information as well. More than 10 million pamphlets describing what to check during a household inspection (the checklist) were distributed in places of heavy foot traffic, such as streets, beaches, restaurants, bars, shopping malls, supermarkets, schools, universities, bus/train/metro stations, ferry terminals, churches, toll booths, and even the Piscinão de Ramos (a popular artificial beach located in one of the most densely populated areas of Rio de Janeiro). The postal service mailed an additional 3 million pamphlets to individual homes. The checklist was also printed in the seven principal newspapers of Rio de Janeiro (*O Globo*, *Jornal do Brasil*, *Extra*, *O Dia*, *O Povo*, *O Fluminense*, and *Jornal de Hoje*) in three editions each, potentially reaching millions of readers.

Organizers distributed a total of 200,000 posters and distributed a third pamphlet with information about what must be done in public areas such as plazas, parks, and construction areas to public managers and to the Civil Construction Industry Union. Schools conducted collective clean-up activities and teachers gave lectures on dengue prevention and homework to check for breeding sites.

While airplanes towed banners about *D-Day* over more than 30 kilometers of beach, three-minute films about dengue were broadcast every half-hour on ferry rides from Rio de Janeiro to Niterói, Paquetá, and Ilha do Governador. Street vendors (*camelôs*) designed and marketed *D-Day* items on their own initiative, selling caps, headbands, tops, and t-shirts with the logo. The state of Rio de Janeiro literally “got dressed” against dengue, and empowered the slogan of the campaign: “Rio is too beautiful to be shut down by one mosquito.”

On the air waves of radio and TV

“Alerting,” “sensitizing,” “informing,” and “mobilizing” were the campaign key words. The *D-Day* campaign was able to access actors in popular soap operas and the most important radio and television personalities to entice the audience to take action on *D-Day*. The starting point for this strategy was through the paid media.

Dengue became an issue between soap opera characters on “*O Clone*” (“The Clone”), at the time the number one program on the most popular and largest Brazilian TV network. This paid media was intensified by other free inserts (similar to U.S. public service announcements that are included in the script), especially after several actors of the soap opera actually came down with dengue. Information about dengue

prevention was also incorporated into the production of *Big Brother Brasil*, a reality show that aired during the same period on the same network.

On the five national TV networks in Brazil (reaching 81% of the target population), three different spots of 30 seconds each were broadcast during the 10 days before *D-Day*. In two of the spots, two famous actors (Lília Cabral and Stênio Garcia), both of whom had dengue, talked about their painful experience with the disease and called upon the population to “defeat dengue” on *D-Day*. In the third spot, the most “irreverent” team of comedians on Brazilian television (Casseta e Planeta) called upon the population to participate and demonstrated exactly how and what needed to be done to eliminate breeding sites of the mosquito. On the Sunday that preceded *D-Day*, the most popular audience participation programs on Brazilian TV networks spoke about dengue and the significance of “personal responsibility” in dengue prevention.

The audio portion of the TV spots were broadcast as radio spots by the most popular radio stations and endorsements were given by 49 radio hosts with large audiences in the Rio de Janeiro broadcast area. Prerecorded three-minute interviews with well-known persons (including the singers Joyce, Zélia Duncan, and Paulinho Moska and the journalist Márcia Peltier) focused on personal accounts about their fight against dengue after they had suffered through the disease and stressed to the ordinary citizen that dengue, in addition to being dangerous, is a “democratic” disease that affects everyone.

In addition, on *D-Day* itself, 10-second spots with reminder messages were broadcast throughout the day, reminding the population of what must be done to eliminate the mosquito. The spots were broadcast by commercial and community radio stations and played on loudspeakers at open air markets, in slum areas, and in supermarkets, as well as by vehicles equipped with loud speakers.

The Minister of Health reminded the population of the problem of the disease throughout the state and of the importance of full participation in the social mobilization campaign in a public address broadcast by radio and television networks the day before *D-Day*.

Evidence that the practice works

According to FUNASA, nearly 4 million families participated in the social mobilization activity on March 9 by inspecting their homes. In addition, 53,000 tons of trash were collected from the streets and more than 3,000 closed homes were inspected across the 90 participating municipalities. The number of support vehicles used in *D-Day* reached 1,089, and more than 745,000 people were directly involved in the action (public employees from the federal, regional, and local level), plus volunteers of NGOs, churches, community associations, and private corporations and enterprises, who were not included in this count.

What did not work

This large-scale social mobilization activity could not have taken place without partnerships between governmental entities, not only among different ministries but more importantly between the various levels of government and other NGOs. Before anything could be organized, the resolution of the debate about which government level was responsible for combating the mosquito had to be resolved.

Sustainability

Based on Rio de Janeiro's positive experience , which showed a rapid and efficient response, the MOH took legal action and created a "National Day of Combat against Dengue" for a national mobilization activity to take place annually on the second-to-last Saturday in November.

Key points to remember

Key Point	Relative Importance*	Why?
Awareness of the population about their responsibility in dengue prevention and control and putting it into practice	Critical	Telephone surveys revealed that dengue was no longer viewed as a “silly disease that bothers but does not kill.” The increasing awareness of the dangers of DHF induced people to take action.
Accountability for and engagement of the three levels of government (federal, regional, and local) and of the organizations and institutions of civil society	Critical	In order to achieve this large-scale social mobilization activity, engagement of and partnerships between different levels of government entities and civil organizations is mandatory.
Advertising campaign with clear objectives and a complete set of materials with precise information about what to do and how to do it in order to eliminate domestic breeding sites of <i>Aedes</i>	Very important	The message should focus on one common activity for the entire population to carry out on <i>D-Day</i> : clean up in and around the house.
Diversification of communication channels to allow increased exposure to the call for participation in <i>D-Day</i> . It was practically impossible for someone in Rio to <u>not</u> notice the mobilization.	Important	An “emotional” atmosphere was created for the mobilization, putting pressure on everyone to embrace the idea. Also, what to do and how to do it on <i>D-Day</i> was so well known that the behavior was almost automatic.
Support on <i>D-Day</i> of the municipal trash collection service, to collect refuse from houses, cemeteries, junk yards, tire storage and recycling facilities, and vacant lots.	Important	A required component that helps to close the circle around the clean-up campaign, it also made people feel that their home-based efforts were valued because the government was able to do its job of collecting trash.
Municipal regulation, laws that allowed health agents to inspect closed households	Not critical but very helpful	Another complementary action that helped to close the circle around the clean-up campaign because breeding sites were cleaned up in and around closed households. The community again felt that the government did its job.

* critical, very important, important, not critical but very helpful

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3.5. Key Container and Key Premise Indices for *Ae. Aegypti* Surveillance and Control

Contributed by: Vu Sinh Nam, Ph.D., Vietnam

Why was this practice selected?

Behavior theories have shown that behavior change is incremental and, once implemented, it needs to be consistently reinforced. Entomological research has shown that in most areas there are a relatively small number of containers that consistently serve as the primary producers of *Ae. aegypti*, with other containers playing minor roles in mosquito production. The survey of “key containers” in use in Vietnam allowed local areas to identify those containers serving as the primary source of adult *Ae. aegypti* mosquitoes and therefore direct all prevention and control actions toward those containers. The use of the “key premise” survey allowed field staff to target households that were repeatedly found with positive containers. These actions followed recommendations in the PAHO and WHO guidelines for the identification of priority breeding sites on which to focus environmental management actions. This example from Vietnam was selected because no examples of use of “key containers” and “key premises” were found as part of national programs in the Americas.

What is the best practice?

A “key container” survey for improved dengue vector surveillance and vector control was developed (1994–1997) and implemented on a regional basis in 1997 in Vietnam. Positive outcomes from the regional pilot resulted in the key container survey becoming part of the entomological surveillance strategies of the national dengue vector control program in Vietnam. Results of recent studies have shown very low effectiveness of adulticide spraying to kill infected *Ae. aegypti* adult mosquitoes during epidemics when compared with the cost of spraying and its impact on the surrounding environment. *Ae. aegypti* breeds and develops in artificial water containers, and its life is closely associated with human activities. Therefore, the most effective method of controlling *Ae. aegypti* mosquitoes is through source reduction to eliminate mosquito larvae from habitats in and around the home, where most disease transmission occurs.

To successfully control these mosquitoes, it is important to gain the participation of the community since they own the containers where *Ae. aegypti* larvae are found. The use of new larval control measures that are inexpensive and easy to use, coupled with their high, sustainable effectiveness (e.g., *Mesocyclops*, a biological agent, is successfully being used in Vietnam), is encouraging for areas at high risk for DF/DHF. However, current vector indices (house, container, and Breteau) have had very low significance in outbreak prediction and expression of the relationship between the number of cases and abundance of the vector. Therefore, developing

practical, easy-to-use indices or larval surveys for vector surveillance and control that might have a better predictive power for DF/DHF outbreaks is necessary.

Describe the process to develop the practice

Results of vector surveillance for *Ae. aegypti* mosquitoes and larvae and the number of cases of DF/DHF in Hanoi between 1987 and 1993 indicate that mosquito density and larval indices, in particular the Breteau index (number of containers positive for *Ae. aegypti* larvae per 100 houses inspected), have no relationship with the number of DF/DHF cases ($r = 0.3478$ and $r = 0.1112$, respectively) (Nam and Kay, 1997).

The problem lies in how the Breteau index is calculated, with a water tank containing 10,000 *Ae. aegypti* larvae equivalent to a small discarded glass jar with just one or two larvae. Nam (1995) showed that there was no correlation between the adult mosquito density index and the Breteau index, between the Breteau index and the mosquito-positive house index, or between the larvae-positive house index and the mosquito-positive house index in northern Vietnam. Although these vector surveillance indices have been in use for many years, they have a very low predictive power for DF/DHF outbreaks or epidemics; other researchers have reached similar conclusions (Service, 1992; Kay and Aaskov, 1996).

Research on key containers was begun in 1994, with the following objectives:

- Determine mosquito productivity of each container type
- Propose specific and effective vector control messages specific for each key container
- Evaluate the vector control program.

Investigation of the major breeding sites (key containers) of *Ae. aegypti* and their locations (key premises) is very useful when conducting prevention and control measures. Results of the investigation in three provinces (Table 3) in northern Vietnam demonstrated that key containers for *Ae. aegypti* in those provinces were water jars, followed by discarded materials and concrete tanks (Nam and Kay, 1997). Therefore, key messages for controlling *Ae. aegypti* larvae in those areas would be the introduction of biological agents, such as *Mesocyclops*, *Micronecta*, or larvivorous fish, to water jars and concrete tanks and the elimination of discarded containers.

The key premise designation is given to any house having more than two *Ae. aegypti*-positive breeding sites. The health volunteers and the MOH health workers then give more attention to the key premises by visiting them more often, spending more time discussing the control methods with the householders, and taking appropriate larval control actions.

Table 3. Results of *Aedes aegypti* Breeding Site Surveillance in Namha, Haihung, and Haiphong, Vietnam, 1996

Type of container			Positive with <i>Aedes aegypti</i> larvae			
	No. of containers	%	No. of containers	%	No. of larvae	%
Concrete tank	824	39.81	44	28.76	2852	26.72
Water jar	387	18.70	55	35.95	4657	43.63
Well	416	20.10	9	5.88	174	1.63
Cistern	61	2.95	2	1.31	27	0.25
Discarded Containers	360	17.39	43	28.10	2963	27.76
Aquarium	13	0.63	0	0	0	0
Bucket	9	0.43	0	0	0	0
Total	2,070		153		10,673	

During the research conducted in the city of Hanoi, the larval productivity of each container type was assessed by determining the number of third and fourth instar larvae (these later stages of larval development reflect survival potential and the last opportunity to intervene at the larval stage). Results of the larval productivity study indicate that the types of key breeding sites did not differ during the dry and rainy seasons; the key containers were consistently positive for large numbers of third and fourth instar larvae throughout the year, with a significant increase during the rainy season (2.23 times more larvae during the rainy season from April to November) (Phong and Nam, 1997).

A second key container survey conducted in 1998 in three provinces in northern Vietnam showed that the frequency of the container in the environment and its *Ae. aegypti* productivity are different for each water container type. Using the results of the key container survey, key messages for *Ae. aegypti* control were developed specifically for the area. For *Ae. aegypti* control, concrete tanks were the most important container, accounting for more than 80% of all *Ae. aegypti* larvae (Kay et al., 2002).

At this time, the key container survey is conducted every three to six months (depending upon location and project), and vector control measures may be changed to reflect new key containers that emerge after successful implementation of intervention activities.

What did not work?

To date, the key container concept seems to have been very useful for the dengue control program in Vietnam. However, counting the larvae in each container during the periodic key container survey is time consuming and more costly in terms of manpower when compared with normal routine vector surveillance activities that produce the general house, container, and Breteau indices. This has led some authorities and entomological team leaders to be hesitant to adopt the new method, although it has been demonstrated that the other indices are not as useful for planning control measures.

Sustainability

The key container survey has been applied in 51 of 61 provinces or cities throughout the country as part of the national dengue control program. The surveys are conducted every six months in at least two districts of each of the 51 provinces or cities. Although entomology team leaders hesitated to accept the new index, when presented with field results, staff recognized the advantages of the new method for vector surveillance and control. The most important factor in acceptance of this new method is to first prove to staff and then to the community that it is indeed useful.

Evidence that the practice works

Results of a three-year study of the control of the two key containers found in three provinces in northern Vietnam (six communes with 11,675 households and 49,647 residents) show high community acceptance and use of *Mesocyclops* (Copepoda) in concrete tanks, eradication or near eradication of *Aedes* larvae in areas with high levels of concrete water tanks treated with *Mesocyclops*, and significant reductions in discarded items through the establishment of recycling programs to encourage the removal of recyclable discarded items (Kay et al., 2002).

The study results have reinforced the direction of the national dengue vector control program to have provinces focus on the key containers that reflect the most common and productive *Ae. aegypti* breeding sites in that area. While this may result in differences among the provinces in the types of vector control measures recommended to the population, it allows each province to establish its vector control strategy using data obtained through the key container survey. By focusing on the containers that are consistent producers of larvae and houses that consistently have *Ae. aegypti* larvae in containers, control measures can be tailored for the specific needs of the area and populace. Key container surveys also permit the entomological teams to promptly detect changes in key containers should the mosquito vector establish preference for another water-holding container.

Key points to remember

Key Point	Relative Importance*	Why?
Water container type	Critical	To determine the breeding sites of <i>Aedes aegypti</i>
Larval productivity	Critical	To calculate the larval productivity of each water container type
Key container for <i>Aedes</i> larvae	Very important	To determine the key containers
Number of <i>Aedes</i> larvae per container	Important	To determine vector control measures

* critical, very important, important, not critical but very helpful

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3.6. Management and Control of Tires

Contributed by: Lourdes Rivas Gutiérrez, Mexico

Why was this practice selected?

The development of effective control methods for *Ae. aegypti* breeding sites requires that the most productive containers first be identified. In a community-based dengue prevention and control program in Mérida, Mexico, it was found that homeowners were unable to implement many of the *Aedes* control strategies the MOH recommended because the message was too vague (e.g., cover tires), it lacked relevance to residents (e.g., throw tires away), or residents were unable to carry out the action (e.g., cut holes in the tires, throw tires away). Although the program intervention focused on the top four *Aedes* breeding sites, this best practice will focus only on the development of control strategies for one of the four targeted breeding sites, tires. The focus on tires was selected given the limited number of options available for tire control and the complete lack of effectiveness of most currently recommended tire control methods.

In this best practice, there are two practices: a process to identify the most important and productive breeding sites in an area with a multitude of container types and a method to deal with used tires that are found, for whatever reason, in the domestic setting. This practice was selected since the process to identify the most productive breeding sites is important for integrated vector control, and the field trial to test novel control methods is an essential part of the process. As a result, the use of lime in tires found on property lots is now recommended through the national dengue prevention and control program.

What is the practice?

In this example, the identification of control methods for *Aedes aegypti* breeding sites, based on the daily activities of the target population, will focus primarily on the prevention of mosquito breeding in tires. The program targeted the southeastern section of the city of Mérida, Yucatán, Mexico. One result of these experiences is that the use of lime as a control method for tires has been incorporated into the national program.

Describe the process to develop the practice

The ideas and observations presented are based on quantitative and qualitative studies carried out by the dengue prevention and control project in the city of Mérida, Yucatán, Mexico, in 1995–1996 (Rivas Gutiérrez and Inette Burgos, 1996), under the direction of the MOH, with funding from the Rockefeller Foundation. The experiences recorded as a result of this program (Méndez Galván et al., 1996) have led to a number of methodological observations for obtaining basic information that will make it possible to effectively implement an *Ae. aegypti* control program.

Phase 1: Formative research

Identification of social conceptions regarding dengue. It is important not to presume that the general population conceptualizes dengue and dengue hemorrhagic fever in the same way that health workers do, nor that the population organizes its life around problems that the MOH identifies as being a priority. Likewise, it is necessary to take into account that many countries have a deeply rooted history of governmental paternalism, which prevents the population from clearly identifying and accepting its responsibility with regard to the prevention of certain diseases such as dengue.

With this in mind, the overall structure of the 1995–1996 phase of the dengue prevention and control program in Mérida was based on the outcome of a previous study which concluded that, although the general population does not view dengue as a priority health problem, it does perceive the existence of mosquitoes and garbage as problems in the community. In addition, the study concluded that heterogeneity and individualism, both of which are characteristic of urban areas with access to necessary public services, are factors that affect or hamper community organization efforts. As a result of these findings, researchers opted to implement a prevention strategy based upon the use of mass media and targeted one-on-one or group interventions.

Determination of the environmental, social, and cultural conditions in the area where the program is to be implemented. To identify areas of greatest risk based on the abundance and productivity of *Ae. aegypti* breeding sites, as well as to plan the education-communication campaign, the studies and interventions were carried out in the southeastern sector of the city, an area containing the most representative neighborhoods. These neighborhoods were selected using socioeconomic statistics from the municipal government and entomological data from the MOH. It was determined that the presence of containers that produce the greatest number of mosquito pupae is not homogeneous in the city, with the most significant problems found in neighborhoods classified as “periphery” (low-income areas) (Lloyd and Rivas Gutiérrez, 1996), where a greater number of water storage containers, animal drinking troughs, and tires were found compared with other types of neighborhoods (e.g., upper, middle, and very poor neighborhoods).

Identification of the source of mosquito breeding. The first step is to determine at what specific stage of development of the vector the cycle is to be interrupted; in this case it was decided to intervene at the pupal stage. The second step is to identify those containers that produce the greatest number of pupae (Nájera Vázquez, 1996) and the type of containers that are found in greatest quantities in the environment. And, the third step is to identify the function that such containers fulfill within the domestic setting so that appropriate control methods can be developed (Lloyd and Rivas Gutiérrez, 1996).

Identification of the most productive breeding sites, based on the functions assigned to the containers. Researchers selected one “general” neighborhood (a middle/lower middle class area) and one periphery neighborhood (a low-income area) to conduct

the pupal productivity study over a period of 10 months. This resulted in a total of 49,674 pupae being recorded in an average of 181 breeding sites. Researchers observed that the production of pupae in containers that the homeowner did not consider to be trash was consistent during the 10-month period, whereas mosquito production in containers that the homeowner considered to be trash items occurred only during certain seasons. The breeding sites were grouped by the function the families assigned to the containers, as seen in Table 4.

Table 4. Percentage of Pupae Produced, by Function of the Container, June–October 1995 (rainy season only)

Function	General Neighborhood		Periphery Neighborhood	
	Average # of pupae	% of pupae produced	Average # of pupae	% of pupae produced
Water storage	634.5	50.2	101.8	29.4
Animal drinking trough	256.0	20.3	33.4	9.6
Plants in water	162.0	12.9	121.6	35.1
No defined use	131.7	10.4	34.7	10.1
Disposable	26.9	2.1	23.0	6.6
Tires	21.5	1.6	13.7	4.0
Other uses	16.1	2.5	18.0	5.2
Total	1,248.7	100.0	346.2	100.0

Data obtained from entomological surveys carried out in prior years were analyzed to determine the *relative percentage of positive containers in the environment*. This was obtained by multiplying the percentage of pupae produced (Table 4) by the percentage of containers found in the environment (in accordance with entomological surveys). The final value produced is a *relative value of the importance of the breeding site* (Clark, 1996) (Table 5).

Table 5. Relative Value of the Importance of the Breeding Site

Function	General Neighborhood	Periphery Neighborhood
Water storage	547.1	270.4*
Animal drinking troughs	261.8	192.9*
No defined use	255.8	100.8.
Other uses	75.5	160.3*
Plants in water	30.9	10.5.
Disposable	24.5	49.6.
Tires	11.7	144.4*

The importance of obtaining the *relative value of the importance of the breeding site* lies in the potential for generalizing, within the city, the identification of the most productive breeding sites, based on their abundance in the environment. Thus, the containers selected for developing community-based control measures were the top four *Ae. aegypti* breeding sites in periphery neighborhoods: containers to store water, containers used as animal drinking troughs, containers used for other purposes, and tires. The most important breeding sites in periphery neighborhoods were selected by determining the lack of access to basic services such as regular trash collection, the number of tires found in those neighborhoods, and the percentage of city residents living in such neighborhoods. (Although the intervention focused on the top four breeding sites, only the process for developing a method for controlling tires will be described here.) Tires were selected as the example since few options exist that result in adequate tire control and there was a need to develop and introduce a new behavior to replace current behaviors that are not sufficient in preventing mosquito breeding.

Phase 2: Development of effective and feasible community-based tire control methods.

For the behavior to be sustained, it was necessary to identify control measures that would be effective in preventing mosquito development and that would be feasible for the homeowner to adopt. First, it was necessary to determine what behaviors the population was currently practicing and what behaviors the population would be willing to adopt to deal with tires in their yards. Second, it was necessary to identify who within the family structure was, or would be, responsible for implementing the recommended behaviors, and thirdly, it was necessary to know what obstacles might exist to prevent adoption of the behavior and how those obstacles could be overcome.

Researchers conducted laboratory-based entomological tests by pouring lime in varying amounts into tires (8, 68, and 160 grams of lime per liter of water), with all three cases producing 100% larval mortality, whereas in the control tire larvae continued to develop normally over the course of the three-week period. Since *Aedes* does not reproduce in salty water, lime was selected for conducting the tests because

it was thought the mosquito would not lay her eggs in water with a low pH., lime is very inexpensive, and it is commonly found in the domestic setting in Mérida.

Behavioral trials were used to validate the feasibility of adopting the practice of adding lime to tires. Six families with tires on their property were asked to perform one of two possible actions: throw away the tires or pour two handfuls of lime into each tire every month. The practice of pouring lime into the tires exhibited a high degree of acceptance because lime was easy to obtain and, moreover, housewives reported satisfaction with this option since it meant “we won’t have to depend on our husbands to do it.”

Phase 3: Message design and dissemination

The cross-disciplinary approach to address the problem (use of behavioral data, entomological tests, and behavioral field trials) made it possible for the communication activities to be planned and implemented with an increased degree of precision (Rogers, 1974). To fully develop the educational communication campaign, a number of social science tools, including focus groups and in-depth interviews, were used to identify the target audience. Housewives, or female heads of households, were identified as the group to which the messages should be directed, as they were directly responsible for the care of the various potential breeding sites of *Ae. aegypti*.

Identification of the target population (Booth, 1992) made it possible to design the campaign messages taking into consideration, among other significant sociocultural factors, the concepts, beliefs, prejudices, language, and information needs of the intended recipients. The in-depth knowledge of the target population made it possible to develop a message dissemination strategy with a high degree of precision, using a number of complementary communication channels, specifically, a combination of mass media (radio and television) and interpersonal communication.

The broadcast schedule for the radio and television messages was structured in accordance with the level of acceptance given to each station or channel and the credibility of the personality or show as a source of information/entertainment reported by the target population (Inette Burgos, 1996). In addition, the use of interpersonal communication activities through direct contact with the target population enabled the adaptation of messages to specific physical and cognitive circumstances.

What didn’t work

It was determined that although housewives did in fact wish to throw away the tires in their yards that were not being used, garbage collection employees either refused to haul them away or charged an additional fee to do so. As a result, the MOH-developed message of “throw tires away” was discarded since it was not feasible.

Sustainability

The formative research exercise, in conjunction with a practice conceived and implemented on a dialectical and cross-disciplinary basis, made it possible to address and understand the problem both quantitatively and qualitatively, focus on it from both social and entomological standpoints, strike a compromise between the ideal and the feasible, and identify the most effective messages and means of communication based on the characteristics of the target audience.

Some of the radio spots developed under the project are still being broadcast today as a means of reinforcing trash clean-up campaigns during the rainy season. The use of lime as a method for controlling tires has been incorporated into the national dengue prevention and control program.

Evidence that the practice works

The key points to be remembered are enumerated below. A number of results obtained during the program period are listed in the following paragraphs (Méndez Galván, et al., 1996):

1. Effectiveness and feasibility of the actions to be promoted.
 - Behavior and laboratory tests were used to determine measures that would be effective in controlling mosquito pupae and that could be feasibly adopted at the household level. In the pre-intervention surveys, only one person mentioned lime as a tire control method; subsequently, 32 households mentioned using lime on tires, and 19 of these reported that they applied it with the appropriate frequency.
2. Use of complementary communication channels.
 - The communication campaign was structured by taking into account the need to use different channels that, by virtue of their characteristics and structure, would be complementary. These channels included radio and television, as well as the use of interpersonal communication at school-based activities and during home visits. Results from the qualitative evaluation of the communication campaign showed no differences in adoption of the tire control behavior between individuals that reported hearing the messages via radio or television and those that reported hearing it at home or through school-based activities. However, differences were found between the groups when examining behaviors related to water storage. This may be due to the fact that the tire message was simple and easy to disseminate via radio and television, while other messages were more complex.

Key points to remember

Key Point	Relative Importance *	Why?
Identification of the most productive breeding sites, as determined by the various functions assigned to the containers	Critical	In order to ensure success, it is necessary to identify the most productive sites and to understand the function that the containers fulfill within the household dynamic.
Effectiveness and feasibility of the measures to be promoted	Critical	In order to design control measures, it is necessary to determine the effectiveness of the measure on controlling the vector, as well as the feasibility of carrying out the behavior at the household level.
Use of a number of complementary communication channels	Critical	Use of multiple channels is critical for the dissemination of messages of varying levels of complexity.
Sociocultural characteristics of the target population and identification of the specific groups toward which the messages are directed	Very important	The success of an educational communication campaign depends to a large extent on identification of the specific population groups to which the messages are to be directed.
Levels of acceptance and credibility accorded to the various communication channels by the target population.	Very important	It is necessary to determine the levels of acceptance and credibility accorded to the various channels by the target population.
Stratification of the city and identification of the most problematic areas.	Not critical, but very useful	Determination of the areas of greatest risk make it possible to put into practice measures focusing on specific problems based on the socioeconomic and cultural characteristics of the residents.

* critical point, very important point, important point, point that is not critical but that is very useful

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3.7. Management and Control of Water Containers

Contributed by: Julia Rosenbaum, ScM, and Elli Leontsini, M.D., M.P.H., Dominican Republic

Why was this practice selected?

The process to identify, modify, or develop *Aedes aegypti* prevention and control methods is based upon established social science and entomological research methods. Most control methods are designed by planners who promote “ideal” solutions. Unfortunately, few dengue prevention and control programs have put resources, including staff time and fiscal resources, into evaluating whether the methods currently being recommend for residents are feasible, effective at the household or business level, or acceptable to the target population.

This example from the Dominican Republic describes the process used to develop a feasible, effective, community-based *Aedes* control methodology that started from the householders’ point of view. The practice of negotiating improved behaviors, or NEPRAM (*Negociación de Prácticas Mejoradas* or Negotiating Improved Practices), was applied to both strategy development and intervention implementation.

What is the best practice?

In this best practice there are actually two practices: the first is how a research process was adapted by the national dengue control program to become the means by which integrated control activities are conducted; the second is the outcome of the research practice—the use of bleach dabbed onto the sides of water drums on a weekly basis to destroy mosquito egg rings. The basic NEPRAM approach for developing an integrated control strategy focused on prolific breeding sites within households and communities. Social scientists and health educators working with the Dominican Republic’s national dengue program adapted the NEPRAM method to involve communities and health planners in developing effective and feasible behavior change interventions through the use of analytical techniques and continuous community feedback. The “back-and-forth” dialogue between entomology laboratory and household patio and between planners and community members constituted the “negotiation.” NEPRAM builds on existing practices and beliefs about water and dengue to identify control practices that are not only efficacious, but also feasible and effective in the community setting.

The national dengue program, municipal health teams, and community health workers adapted NEPRAM, the practice of “negotiating behavior change,” as an intervention technique in which, rather than “promoting” or imposing ideal behaviors for water storage container control, home visitors “negotiate” improved behaviors with residents--a dramatic shift in program practice. Health workers are no longer just

educators, but facilitators of change on an individual basis. During the pilot intervention period, negotiation was extended to soliciting and organizing participation of community-based organizations active at the local level in *Ae. aegypti* control.

Describe the process to develop the practice

Negotiating improved behaviors was originally conceptualized as a technique for developing and testing interventions. In this form, additional formative (social science) research is prerequisite, and three phases of formative research are recommended to identify feasible and effective dengue control behaviors focused on key containers responsible for *Aedes* infestation, as identified through entomological surveys.

Phase 1: Formative research

Through in-depth interviews and observations, researchers document household knowledge, perception of dengue risk, and extensive information on key containers and their use.

In the case of the Dominican Republic, the key containers are water storage drums (generally 55-gallon metal drums). Therefore, interviews and observations focused on water sources, storage, maintenance, and use. Cleaning practices for the water storage containers were observed and documented.

The findings showed that maintaining the cleanliness of the stored water was a high priority for families, who committed a lot of effort to achieving it. Their focus, however, was on general hygiene rather than dengue concerns. Researchers found that most of the water storage drums were covered with any handy piece of material that, although it protected the water from litter or pests, did not provide a hermetic seal that would prevent oviposition by *Aedes* mosquitoes. Similar to other research settings in Mexico and Honduras, the relationship between the mosquito's aquatic and adult stage was largely unrecognized, and mosquitoes were perceived to be a nuisance coming from habitats outside the household. Lastly, researchers discovered that housewives commonly used household bleach to clean the drums and sprinkled it as a sterilizing agent into freshly refilled drums to kill bacteria in the water.

Phase 2: Idea generation and efficacy testing

The interagency team evaluated the formative research findings and looked for existing practices that might be modified slightly to yield effective dengue prevention strategies. Standard washing techniques involving the use of detergent and water weren't always feasible because of the extreme scarcity of water in the Dominican Republic setting, making the need to thoroughly rinse the container to remove any detergent residue impractical. From these discussions the idea arose to experiment with a bleach-only means of *Aedes* control.

In trials conducted at the entomology laboratory of the National Center for the Control of Tropical Diseases, it was found that the application of straight bleach directly on the walls of infested drums caused very few eggs to hatch afterwards. Therefore, regular bleach treatment of eggs deposited at various water levels would eventually destroy all or most egg rings before they had a chance to hatch. In addition to using bleach, researchers developed and tested two improved drum covers.

Phase 3: Negotiation/effectiveness and feasibility trials

In the end, the trials identified four behaviors (two bleach-based and two drum covers) that were efficacious in the laboratory in preventing development of the larval or adult stages of *Ae. aegypti* and would be used for field trials or “negotiation” (NEPRAM). One bleach behavior, known as “complete cleaning,” involved cleaning the drum as usual and then dabbing straight bleach directly on the walls of the entire drum, pouring some bleach on the bottom of the empty drum, and waiting 15 minutes before refilling the drum. The second bleach behavior was for use when water was scarce and the drum couldn’t be emptied for a thorough cleaning. This behavior, “dabbed bleach,” involved dabbing straight bleach onto the exposed walls of the drum just above the water level, focusing on the area where *Aedes* would have been most likely to lay her eggs rather than on the entire wall. Householders were asked to practice one of the two bleach behaviors once a week. The other two behaviors involved using simple new drum covers.

During the NEPRAM trials, the behaviors were introduced as part of a negotiation process. The researcher visited a small number of households and invited the householder to try up to four of the new improved behaviors. A key point is that the researcher placed the new behaviors in the context of ways to improve water-related hygiene, not just for dengue control. The householder was asked to help determine whether these behaviors, known to be efficacious in a laboratory setting, might be feasible and “effective” in a householder’s daily activities. They discussed impressions, difficulties, and perceived advantages and disadvantages for each behavior during the researcher’s return visits, and solutions were negotiated on the spot. For example, one difficulty that householders identified was the harsh effects of bleach on bare hands during dabbing. The solution that emerged from these discussions was to use a plastic bag as a glove to protect the hand. Researchers asked each householder to provide modifications that would make the behaviors more feasible, and these modifications were then evaluated in the laboratory to ensure that the behavior was still effective.

The results of the NEPRAM trials were positive in that people thought the bleach application behaviors were reasonable, and they actually tried both bleach behaviors and noted that each one had a role, depending on the situation. The promotion of these behaviors then became part of the new strategy for preventing *Ae. aegypti* breeding in water storage drums.

Phase 4: Involvement of community-based organizations

A final research activity conducted was to study the community-based organizations active in the proposed area of implementation. This involved learning their interests, understanding their constituencies, and negotiating with them regarding what kind of involvement they were willing to offer to make the program sustainable and community based. The next step was to form a planning committee, which met regularly during all phases of the pilot intervention. The planning committee identified the principal means to mobilize the community as house-to-house visits, with home visitors using a negotiation model during the visit: listen, introduce new behaviors, negotiate use, and problem solve with the family. Volunteers from the various organizations received training on how to conduct the household visits, and each household was visited at least three times during the course of the intervention. Support activities included the distribution of print materials such as stickers outlining the steps to follow in caring for the water storage drums and the airing of a public service announcement reinforcing the bleach-dabbing steps. The mix of community-based organizations varied in each neighborhood; for example, a youth group was more active in one neighborhood, while a mothers' club was more active in another; college students participated in all areas.

Behavior-related research identified effective *Aedes* control behaviors that were an improvement over existing ones, were based on current practices in order to be feasible, and yet proved efficacious in entomology lab tests. The behaviors were promoted from the householder's point of view, not that of the public health professional, making them appealing and worth the effort to perform.

What did not work?

The improved designs for the drum covers were not well executed, so it was no surprise that they were not well received. Two types of covers had been designed to fit householders' ideal criteria : they should be permeable to allow rainwater to enter; be flexible in their circumference so they could make a hermetic seal on a range of drum types (plastic, cement-reinforced steel drums, etc.); and allow for opening and closing with one hand, so that the other hand could hold a full water container.

While the covers technically fit these criteria, the "hoop type" (*tipo arco*), a cover with a wire lariat seal, was too shallow with too small a circumference for easy use. The "four rocks type" (*tipo cuatro piedras*), a piece of plastic burlap with four corner pockets for stone weights in each corner, was designed in such a way that the stones fell out when covering and uncovering the tanks. Although the negotiation was designed to problem solve on the spot, shortcomings in the cover designs were not addressed during this phase--an oversight in retrospect.

Sustainability

After initial implementation in the urban community of Herrera, several other communities of Greater Santo Domingo followed suit; these included Los Alcarrazos,

Barrio Felicidad, and Los Mina Viejo. In general, priority was and continues to be given to communities where dengue cases are being reported. Two years later (2001 and 2002), and under a new government administration, the regional health offices that form the decentralized health system have implemented the activities of NEPRAM and dabbed bleach in several other geographical areas, including Santiago de los Caballeros, Azua, Moca, Las Vegas, Baní, and Bonao (information provided by the Office of Health Education and Health Promotion [DIGPRES]).

Future plans include integration of the strategy within the healthy cities initiative (*Municipios Saludables*). An unexpected outcome was the impact of the methodology itself. According to the National Center for the Control of Tropical Diseases, the NEPRAM process is being applied to other technical areas, one being the National Lymphatic Filariasis Control Program where community-based behaviors for the control of *Culex* mosquitoes--vectors of the disease--are being developed.

Potential threats to sustainability include the following:

- The need of ministry staff to work during unconventional hours, i.e., evenings and weekends when residents are home, which implies a change to a more flexible work schedule and/or remuneration for extra hours worked
- The increase in operational costs, such as transportation, telephone communications, per diems, and meetings costs (*refrigerios*), not normally included in conventional *Ae. aegypti* program budgets
- The challenge that the negotiation itself presents to conventional hierarchical chains of command prevalent not only in the health system, but among government employees in general.

Evidence that the practice works

A qualitative case study documented the effect of the best practice on the planner's and community health worker's behavior (Padilla, 2001). On an individual level, participants of the planning team acknowledged that NEPRAM had challenged them to think and act differently. Case study participants all acknowledged the novelty and advantages of working in an interdisciplinary team of entomologists, social scientists, and educators. Many noted the novelty of planning from the audience point of view, rather than from a public health standpoint. Most noteworthy to them was the notion of "negotiating" rather than imposing behavior change, beginning with existing practices rather than introducing ideal but alien ones, and the very notion of giving communities "options" rather than "the answer." Most had applied the practice of negotiating improved behavior to another technical area.

At the household level, participants acknowledged that as a result of the practice, their water was cleaner and more sparkling, was free of microbes including mosquito

larvae, and remained clean for a longer time, while the innovative use of bleach was quite ingenious.

Quantitative data available are still at the small-scale level. Chlorine levels in the stored water following bleach applications remained within the recommended levels for drinking water, probably due to the relatively small amounts of bleach used, the use of a sponge during application which minimizes running of excess bleach into the body of water below, and the rapid evaporation of chlorine. Mosquito infestation was reduced as a result, with the presence of eggs decreasing from 64% to 31% and the presence of larvae from 51% to 32% in 49 containers found in the 20 study households. There was an attempt to measure impact at a larger scale during normal program conditions (effectiveness), but operational shortcomings have made the data analysis difficult.

Key points to remember

Key Point	Relative Importance*	Why?
Appropriate management of specific containers based on householders' current and projected use (not health officials assessment of their importance).	Critical	Increased feasibility and sustainability. What is "our" garbage may be a householder's future resource. Efforts to "clean up and get rid of garbage" will fall on deaf ears if the householder considers the item valuable for current or future use. Therefore, specific management or disposal strategies should be conceptualized and tested with householders to identify appropriate solutions that reduce <i>Aedes</i> breeding.
Look for existing practices to build on, rather than introduce new ones.	Critical	Increased feasibility and sustainability.
Test for efficacy of new behavior in the entomology lab.	Critical	In order to know that the behavior is efficacious at least under ideal conditions.
Test for acceptance and feasibility through small scale behavioral trials where householders become program consultants.	Critical	Saves a lot of time and mistakes at the implementation phase!
Offer people behavioral options.	Critical	As seen in this example, two alternatives for bleach application were offered in order to accommodate more than diverse realities and conditions.
Link behaviors to a perceived priority which may not necessarily be dengue.	Critical	Particularly relevant for long-term prevention campaigns, even though the actual behaviors promoted may be the same.

* critical, very important, important, not critical but very helpful

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3.8. Clinical Case Definitions for Dengue Fever, Dengue Hemorrhagic Fever, and Dengue Shock Syndrome

Contributed by: José Rigau, MD, MPH, CDC Dengue Branch, Puerto Rico

Why was this practice selected?

The CDC Dengue Branch serves as the CDC entity responsible for conducting applied research on dengue prevention and control, training health care professionals, and providing technical assistance to countries in the region of the Americas. The CDC Dengue Branch is also a WHO collaborating center.

What is the best practice?

The best practice is the use of standardized clinical case definitions for DF, DHF, and DSS.

Dengue fever

According to PAHO, a case of DF is defined as a patient with an acute illness with fever and two or more of the following manifestations: headache, retro-orbital pain, myalgias, arthralgia, rash, and hemorrhagic manifestations (PAHO, 1994). WHO added leukopenia to this list of manifestations (WHO, 1997).

Dengue hemorrhagic fever and dengue shock syndrome

A case of DHF is defined, according to the PAHO/WHO guidelines, as a patient with a clinical illness that fulfills all of the following four criteria: fever (or recent history of acute fever), any hemorrhagic manifestation, thrombocytopenia ($\leq 100,000/\text{mm}^3$), and objective evidence of increased capillary permeability. The latter may be documented by hemoconcentration (hematocrit increased by $\geq 20\%$ over baseline or over the known average for the population of that age, gender, and location, or decreased an equivalent amount after intravenous fluid therapy), pleural or abdominal effusion (by radiography or other imaging method), or hypoalbuminemia or hypoproteinemia. Cases of DSS meet all these criteria and show hypotension or narrow pulse pressure (≤ 20 mm Hg), or frank shock.

Sometimes the severe syndrome is labeled DHF/DSS, but as the definition makes clear, DSS is a more severe case of DHF. DHF severity is divided into four grades, and a patient with grade III or grade IV would have a diagnosis of DSS. Therefore, all cases of DSS are also cases of DHF, but only the most severe cases of DHF are DSS.

For exact wording, please refer to the PAHO (1994) and WHO (1997) guidelines. In addition, the CDC and PAHO/WHO guidelines include laboratory and epidemiologic criteria for considering the cases as “reported,” “probable,” or “confirmed.”

Describe the process to develop the practice

The effort to establish a standard case definition for severe dengue was motivated by the occurrence of outbreaks in the 1950s of a new and severe disease that was eventually identified as DHF. In 1975, WHO published the recommendations of a group of experts for a clinical case definition for DHF and DSS, said to result in a 90% laboratory confirmation rate. This definition was maintained in the subsequent editions of that document (1980 and 1986). Its wording was edited for clarity and precision in the dengue guidelines PAHO published in 1994, and the new wording was adopted in the 1997 edition of the WHO guidelines.

Repeated studies have shown that a clinical definition for DF has low specificity and sensitivity, because although the symptoms of dengue are well known, many other illnesses also have similar symptoms. The 1994 PAHO guidelines, recognizing that “it is not appropriate to adopt a detailed clinical definition,” nevertheless published a definition for DF to provide a contrast to the clinical syndrome defined as DHF.

What did not work?

As indicated above, there have been several versions of these definitions. The 1994 PAHO guidelines were published only after a series of regional meetings in the Americas served to reach an agreement on the definitions.

Sustainability

The DF definition has become part of many national guidelines, but it serves only for orientation. In practice, few or no jurisdictions in the Americas demand that cases fulfill the DF criteria for reporting or for inclusion in national statistics.

The DHF definition is necessary to allow international comparisons and has been used in excellent clinical studies, but it has not been easily applied in disease surveillance because it requires a large number of laboratory tests, taken at different stages of the illness. Documentation of DHF cases that fulfill all PAHO/WHO criteria is only possible in locations with an abundance of diagnostic resources. Consequently, even in scientific articles there is ample use of the “DHF” diagnosis with concurrent evidence that not all criteria for the diagnosis were met (usually because data were unavailable).

These departures from the recommended definitions indicate that at the population level (individual doctors or hospitals), or even the national program level, there is some adaptation of the criteria to local conditions. Unfortunately, it is not possible to know how much of the deviation from criteria may be appropriate (e.g., a patient with fever, hemoconcentration, some hemorrhage, and a platelet count of 125,000, with a

positive dengue laboratory test should be considered DHF) or inappropriate (e.g., a patient with fever and mild hemorrhage might be called DHF, even if there is no hemoconcentration).

Evidence that the Practice Works

The DHF definition as stated by PAHO and WHO has been useful for comparisons of international public health statistics and cohort and clinical studies to define disease risk factors. For medical training it has served to focus clinical care on the replacement of fluids and the prevention of shock (therefore monitoring of blood pressure) to reduce the case-fatality ratio of DHF/DSS. Its components (the four DHF criteria, plus the blood pressure criteria for DSS) are useful to describe the chronology of disease manifestations, which is as important for clinical recognition as the identification of the criteria.

Key points to remember

Key Point	Relative Importance*	Why?
Four criteria for DHF	Critical	Patients and many doctors think that DHF means dengue with hemorrhage, which is not the case. All four criteria must be met.
Criterion on excessive vascular permeability	Critical	This is what can kill the patient – the excessive vascular permeability that may lead to shock. It is therefore what must be defined and treated promptly.
Blood pressure	Critical	Monitoring of blood pressure is critical, because shock may develop quickly.
Lesser emphasis on platelets, bleeding	Important	Physicians may rely on platelet counts or the presence of bleeding as the markers for severe disease, but they must be educated to consider the four criteria for DHF.

* critical, very important, important, not critical but very helpful

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3.9. Case Treatment and Management

Contributed by: José Rigau, MD, MPH, CDC Dengue Branch, Puerto Rico

Why was this practice selected?

The CDC Dengue Branch serves as the CDC entity responsible for supporting applied research on dengue, training of health care professionals, and technical assistance to countries in the region of the Americas. Appropriate case management and training of physicians in case management of DF/DHF are essential for reducing case fatality rates.

What is the best practice?

The best practice is appropriate case treatment and management for DF, DHF, and DSS, according to standard case management practices described by PAHO and WHO (Rigau-Pérez, et al., 1998).

Many detailed descriptions of the treatment of DF, DHF, and DSS have been published in medical literature and in different country-specific documents. Standard recommendations can be found in the PAHO 1994 publication, *Guidelines for the prevention and control of dengue and dengue hemorrhagic fever in the Americas*, and the World Health Organization's 1997 guidelines, *Dengue haemorrhagic fever: diagnosis, treatment, prevention and control*. 2nd ed.

In general, treatment of DF is directed toward relief of symptoms (fever, aches, and general malaise) and maintenance of hydration by oral ingestion. In contrast, treatment of DHF is directed towards the maintenance of adequate blood pressure and prevention of shock and severe bleeding, through oral or intravenous fluid administration. Treatment of DSS requires in-hospital care that is usually intensive, and such treatment cannot be described in detail in the summary that follows (PAHO, 1994; Rigau-Pérez, et al., 1998).

Dengue fever

Patients with DF require rest, oral fluids (compensating for the fluid lost in diarrhea or vomiting), analgesics, and antipyretics for high fever (acetaminophen or paracetamol, avoiding aspirin so platelet function will not be impaired). With the earliest suspicion that the patient may be developing a severe illness, an intravenous line should be placed so fluids can be provided. It is important to monitor blood pressure, hematocrit, platelet count, the occurrence of hemorrhagic manifestations, urinary output, and the level of consciousness.

Dengue hemorrhagic fever and dengue shock syndrome

Plasma leakage in DHF is very rapid, so the hematocrit may continue to rise even while IV fluids are administered, but the “leaky capillary” period is short; the need for IV fluids is usually only one to two days. There is great variability from patient to patient, and the physician must carefully adjust treatment using serial hematocrits, blood pressure, and urinary output. Insufficient volume replacement will allow worsening shock, acidosis, and disseminated intravascular coagulation, while fluid overload will produce massive effusions, respiratory compromise, and congestive heart failure. Because patients experience loss of plasma (through increased vascular permeability into the serous spaces), they must be given isotonic solutions and plasma expanders, such as Ringer’s acetate or Ringer’s lactate, plasmanate, and dextran 40. The recommended amount of total fluid replacement in 24 hours is approximately the volume required for maintenance, plus replacement of 5% of body weight deficit, but this volume is not administered uniformly throughout the 24 hours. A bolus of 10–20 cc/kilo of an isotonic solution is given in case of shock and repeated every 30 minutes until circulation improves and an adequate urinary output is obtained. Vital signs should be measured every 30 to 60 minutes, and hematocrit every two to four hours, then less often as the patient’s condition becomes stable. The use of steroids in the treatment of DSS has shown no benefit.

The placement of a central venous pressure (CVP) line is hazardous in patients with hemorrhagic tendencies, but may be necessary, especially when more than 60ml/kilo of fluids has been given without improvement. A skilled physician should place the CVP line in a special care area, and this will serve to estimate filling pressures and guide further intravenous fluid administration. An arterial line will help in the assessment of arterial blood gases, acid-base status, coagulation profiles, and electrolytes in the hemodynamically unstable patient, helping to identify early respiratory compromise.

Monitoring should be continued for at least one day after the patient’s defervescence. Once the patient begins to recover, extravasated fluid is rapidly reabsorbed, causing a drop in hematocrit. Before hospital discharge, the patient should fulfill the following six criteria: absence of fever for 24 hours (without the use of antipyretics) and a return of appetite; improvement in the clinical picture; hospitalization for at least three days after recovery from shock; no respiratory distress from pleural effusion or ascites; stable hematocrit; and platelet count greater than $50,000/\text{mm}^3$. Because it is frequently difficult to obtain convalescent-phase samples, a second blood sample should always be taken from patients on the day of discharge from the hospital.

Transfer of patients from a local to a referral institution should follow a specified protocol, such as that developed by the Pediatric Hospital No. 1, Ho Chi Minh City, Vietnam. Criteria for the selective referral of very severe cases (DSS cases with serious prognosis) are the following:

- Massive bleeding (may need blood transfusions)

- Dengue encephalopathy
- Respiratory or hepatic failure
- Recurrent shock
- Prolonged shock, with another underlying disease.

Case management before transport is as follows:

- Try to get the patient out of shock
- Assign a nurse or doctor to travel with the patient to the referral hospital
- Use an ambulance with an oxygen administration system
- Make sure the referral document is legible and complete
- Call the referral hospital before the patient is sent.

Describe the process to develop the practice

These treatment recommendations are the result of decades of clinical experience, especially in Southeast Asia. They have been validated elsewhere, as shown by their acceptance by experienced clinicians in the Americas. Very recent attempts at developing evidence-based recommendations have not produced major changes in the recommendations thus far (Halstead, 2002).

What did not work?

Many DF cases, and all DHF cases (by definition), show low platelet counts. Severe dengue cases may bleed profusely, and improperly managed DHF cases, with prolonged shock, may develop disseminated intravascular coagulation and massive bleeding. Therefore, in locations with little experience in dengue case management, patients often receive steroids, platelet transfusions and blood transfusions, putting great strain on blood banking resources. In general, low platelet counts in dengue cases do not require treatment with transfusions. When patients are diagnosed and treated promptly and appropriately with intravenous fluids, hemorrhages are prevented and requests for blood transfusions are reduced markedly.

Sustainability

Most countries in Asia and the Americas use the PAHO/WHO recommendations, with minor adaptations for local conditions.

Evidence that the practice works

As indicated above, these treatment guidelines have helped reduce case-fatality rates in Southeast Asia and the Americas.

Key points to remember

Key Point	Relative Importance*	Why?
Four criteria for DHF, criterion on excessive vascular permeability	Critical	This is what kills the patient – excessive vascular permeability that may lead to shock. It therefore must be defined and treated promptly.
Blood pressure	Critical	Monitoring of blood pressure is critical, because shock may develop quickly.
Alarm signals	Critical	Physicians must be aware of indications of impending shock: sustained vomiting, severe abdominal pain, abrupt change in temperature (from fever to hypothermia), change in mental status (obtundation or combativeness)
Avoidance of aspirin	Critical	Must educate not just doctors, but the public at large.
Lesser emphasis on platelets, bleeding	Important	Physicians may rely on platelet counts or the presence of bleeding as the markers for severe disease, and they must be educated to consider the four criteria for DHF.

* critical, very important, important, not critical but very helpful

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3.10. Primary School Curriculum for Comprehensive Vector Control

Contributed by: Annette Wiltshire, Trinidad and Tobago

Why was this practice selected?

Few dengue prevention and control school-based curricula have been jointly developed by Ministries of Education and Health, leading to a lack of acceptance of dengue-related activities by teachers and Ministries of Education and a lack of sustainability for MOH efforts to integrate vector control into the formal education system. This best practice example of a curriculum was the first school-based vector control curriculum to be developed from the perspective of the Ministry of Education, and is based upon theories for primary school education that reflect the framework within which school subjects are taught in the region. An educator with curriculum development expertise developed this curriculum, with support from a multidisciplinary advisory group that included health professionals and vector control specialists.

What is the best practice?

Under the Caribbean Cooperation for Health (CHC, PAHO)/Government of Italy “Integrated Program for the Control of *Aedes aegypti* in the Caribbean,” a school-based initiative was introduced. This was a curriculum intervention that introduced a “Reducing Pests and Insect Vectors” module into the existing Health and Family Life Education program of 15 primary schools spread across the English-speaking Caribbean. This area represented some 8,000 students between the ages of five and 12 years and 350 teachers.

A multidisciplinary group of school principals, teachers, curriculum developers, health educators, environmental health officers, entomologists, environmentalists, and parents developed the curriculum, which reflects a bio-psycho-social framework. The scope of the curriculum was extended from merely teaching about mosquitoes to include teaching about other relevant environmental issues that affect the home, school, and community related to pests and vectors as well as the disposal of waste materials.

Describe the process to develop the practice

The advisory group determined that the most convenient and desirable method of delivering the curriculum was by means of a combination of infusion into already existing subjects (e.g., sciences, social studies, composition) and direct delivery. The main topics of the curriculum were as follows:

- The habits of common pests and insect vectors

- What humans do to assist their proliferation
- How humans can protect themselves from pests and insect vectors
- How pests and insect vectors can be controlled in the environment
- How pests and insect vectors affect national development.

Teaching strategies were aimed at creating action-oriented and participatory learning experiences with strong links to the home and community. Home/school/community communications suggested ways in which support and reinforcement could be provided for classroom activities, and many activities assigned to the students were not limited to the school environment. The school's administration was charged with the responsibility of providing opportunities within the school itself for the students to practice newly acquired skills and behaviors. Skills taught included collecting and interpreting data, identifying school needs, relating problems to causes, predicting future effects/outcomes, interpreting charts, learning to problem solve, making informed decisions, learning how to cooperate, sorting, basic gardening, interviewing, and training in advocacy.

Phase 1: Formative research with school leaders

School principals participated in a workshop that introduced them to the global problem of dengue, with emphasis on the English-speaking Caribbean. Workshop activities included the following:

- Determining areas where teachers/students have control over their health as it relates to the environment
- Exploring, as leaders, the feelings, attitudes, and values that contribute to the quality of the school environment
- Critically examining the effectiveness of approaches currently used in helping children to develop requisite knowledge, attitudes, skills, and responses to the issues of environmental preservation and enhancement
- Exploring strategies for establishing partnerships to facilitate achievement of certain goals while striving to create support both in and outside the school for curriculum implementation, sharing information, and developing skills.

Phase 2: Formative research with community members

Baseline data on the needs of students and their communities were collected in each country through knowledge, attitudes, practices, and behavior (KAPB) surveys targeted at adults, conducted as part of the wider project, and through focus group discussions with children. The information gathered influenced curriculum content, development of materials, and home/school/community activities and linkages.

Phase 3: Design of curriculum with ministries of education participation

The Ministries of Education were encouraged to “own” the project – a deliberate strategy to ensure implementation and sustainability, as opposed to their traditionally short-lived involvement in health sector initiatives.

Phase 4: Design of curriculum with MOH technical assistance

Maximum use was made of the technical resources of the Ministries of Health, i.e., resource persons, educational materials, and equipment.

Phase 5: Training

Monitoring and evaluation of the curriculum were stressed from the beginning. The major goal of the curriculum was that students appreciate the role and importance of certain aspects of the environment to their life and health. From an understanding of the relationship between their behavior and environmental sanitation and health, they would engage in behaviors aimed at reducing health risks associated with selected vectors of disease. The following concerns were addressed while developing the curriculum:

- Meeting the needs of children and involving families and communities
- Working for attitude and behavior change
- Forming an action-oriented curriculum
- Using participatory learning approaches
- Building on existing curricula
- Conveying a sense of urgency regarding the threat of dengue
- Meeting the competency needs of the teachers
- Attaining sustainability.

Each teacher was given the full curriculum along with a set of resource materials developed to support that curriculum. Teachers would then be able to reference the materials as-needed—an important feature if the curriculum is designed to be infused across subject areas.

Phase 6: Dissemination of Curriculum

Principals introduced the curriculum at P.T.A. meetings, stressed the importance of home/school linkages, and identified how the school initiative fit into the wider “integrated vector control program.”

What did not work?

Previous attempts to deliver *Ae. aegypti* prevention and control educational sessions did not produce the desired behavior and attitude changes. Curricula were skewed in the direction of information giving and directive teaching styles. The “whole school approach” was not always employed, and this limited the provision of a consistent and sustained environment in which children could practice newly acquired habits and appreciate and experience positive results. The importance and urgency of making a shift was clear.

Sustainability

To date, the curriculum continues to be used at the national level at the schools of the initial pilot project. There has been a fair level of diffusion to other schools. The following are some of the challenges to sustainability:

- Teacher training as attrition occurs
- Pressures of curriculum load
- Focus on subject areas that are part of the national or regional examinations (examinable subjects) versus subjects that are not part of national examinations (nonexaminable subjects)
- Ongoing availability of resource materials
- The tendency to be “seasonal” in response to dengue at the national dengue control program level
- Ongoing involvement of health sector personnel.

Evidence that the practice works

This practice used a single group time series evaluation design, i.e., the persons in the program acted as their own control, and measurements were taken at different intervals before, during, and after the program. It was decided not to use control schools since the wider “integrated vector control program” would certainly have some impact on students, especially in the area of knowledge and information about *Ae. aegypti* mosquitoes and dengue.

Teachers conducted the formative evaluation while the project consultant was responsible for carrying out an impact evaluation. The summative evaluation included information obtained from observations, interviews with principals, teachers, and parents, and structured questionnaires. An independent qualitative evaluation of the project was also conducted as part of the evaluation of the “integrated vector control program” initiative.

The following list summarizes the evaluation findings:

- Positive gains in knowledge by students and teachers
- Positive changes in health-enhancing attitudes and behaviors
- Demonstration of social responsibility via involvement in school and community projects
- Student advocacy for improvement of the environment
- Successful school participation in environmental sanitation competitions
- Creation of an annual “Children’s Environmental Summit” by one of the countries
- Self reports by students of helping to improve the home environment
- Creativity in the composition of songs, poems, and skits related to vector control
- Active involvement of parents and community in support of the school program, e.g., incinerator construction, erection of fences to keep stray animals off school property, clean up of public areas, and gardening, among other activities
- Reduction of *Ae. aegypti* breeding sites at schools and homes
- Reduction of other insect vectors and pests at schools and homes
- Reduction in garbage generation at school
- Sorting of trash for recycling at school
- Composting
- Student breeding of larvivorous fish for the community
- Revival of school vegetable and horticultural gardens
- Participation in radio/television vector control programs
- Conducting of street marches to highlight issues related to dengue.

Key points to remember

Key Point	Relative Importance	Why?
Active involvement of school principals from the beginning	Critical	Without their support, classroom instruction will gradually fade as teachers would tend to consider the curriculum optional.
Providing support for teachers at critical points in the implementation process	Critical	Enthusiasm is high soon after training but can wane as practical problems and issues arise.
Action oriented/participatory learning curriculum and ensuring that each teacher receives the full curriculum and set of resource materials.	Very important	Information alone does not change behaviors and attitudes, and teachers will use the curriculum if it is readily at hand.
Effective monitoring	Very important	One has to be continually aware of what is happening and whether any revisions are required.
Home/school/community linkages to support the learning process	Very important	The teacher's job is made easy by building partnerships to extend support and reinforce what takes place in the classroom, as well as to open up the arena for real life practice by students.
Seed money to support curriculum implementation	Not critical but very helpful	Many schools are strapped for money to buy materials to support curriculum delivery.

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3.1 1. Cross-training of Ministry of Health and Municipal Government Staff in Environmental Management for Integrated Vector Control

Contributed by: Dennis Kalson, REHS and Herbert Caudill, Honduras

Why was this practice selected?

Per the PAHO (1994) and WHO (1997) dengue guidelines, vector control for dengue prevention has been squarely placed within an environmental management framework, focusing on integrated vector control (addressing all vectors found in the community). This approach is reflected in the creation of a new staff category by the Honduran Ministry of Health, that of an environmental health technician (EHT).

In Honduras, the reorganization of the way environmental health issues are to be addressed at the local level is in line with current health sector reform efforts to place the management and provision of health services within the responsibilities of local government. The EHTs are cross-trained to address the environmental issues that many single disease programs, including dengue control, malaria, water safety, and food hygiene, currently face but do not adequately address. The EHT will address vector control issues on a regular basis, and provide support to emergency response activities during a dengue outbreak; the difference is that mosquito control will become a routine activity conducted at the same time that other issues are addressed so that each interaction with residents or business owners becomes an *Aedes* control opportunity.

What is the best practice?

The best practice is strengthening local capacity to manage environmental health issues by training EHTs to address broader environmental problems, including dengue control, malaria, rodent control, solid waste management, and food sanitation, among other topics.

A key strategy in the Honduran approach to effective dengue control is closely associated with an ambitious effort to restructure its environmental health system and to strengthen overall environmental health capacity at the local level. The strategy is part of a nationwide health effort to improve institutional efficiency and effectiveness through health sector reform.

The MOH envisioned the EHT as a field technician capable of managing a full range of health problems related to the environment, recognizing and responding to environmental health needs, and defining and executing disease prevention activities.

involving intersectoral collaboration, local environmental health surveillance, and community participation.

By integrating trained EHTs into municipal services, the technicians become strong agents for influencing public health outcomes in their community. They can assist municipalities in assessing and prioritizing environmental health risks, and can build solutions to the myriad of environmental health problems confronting communities. The new EHTs are well suited to conduct ongoing dengue control activities since their work brings them in close contact with multiple segments of society, thereby facilitating integrated approaches through mosquito habitat control, identification of local practices, and community organization.

When fully realized, the environmental health system will include a total workforce of 700 EHTs (field workers and supervisors) who will operate at the local level under regional administrations. They will assume the responsibilities of nearly 1,400 single-program technicians in the current MOH system. It is anticipated that one EHT will serve the needs of approximately 10,000 residents. To date, 300 EHTs have completed training and 120 are enrolled in advanced training to fulfill supervisory functions.

To improve lines of supervision, the MOH has developed additional training for qualified EHTs to assume roles as mid-level managers. As members of the regional management team, the EHT managers will strengthen coordination and support for environmental health technicians in the field. Regional EHT coordinators also serve on a national technical advisory committee to assist the central levels of the MOH define program needs and direction.

Describe the process to develop the practice

With the help of the USAID liaison to facilitate the process and monitor progress, the program goal is to convert a workforce of 1,400 single-program field technicians in nine health regions into 700 EHTs through training and field practice. The training program includes a 15-week course covering 12 environmental health modules ranging from food sanitation, garbage management, and drinking water quality, to vector control, wastewater management, and rabies prevention. Training topics also include legal aspects of environmental health, basic risk assessment, and social mobilization. Highly qualified program specialists from the central level of the MOH prepared the modules and are teaching the courses. At least four training courses are offered each year at locations convenient to the local health regions, and attendance is at 35 to 40 students per course.

In addition to classroom training, the EHTs are required to complete an eight-month on-the-job practicum, and must complete a field project or thesis within their assigned community. The field thesis begins with an in-depth environmental health assessment of the community, through which the EHT identifies a specific issue to work on. At the end of the eight-month field practicum, the candidate must present

his/her field thesis to a panel of instructors from the training course before becoming a fully credentialed EHT.

To capitalize on existing human resources, EHTs were initially selected from the technical workforce of local program specialists, e.g., dengue and malaria control field staff, water and sanitation field specialists, and health promoters. Those who fail to meet minimum qualifications are allowed to continue their employment as environmental health aides assisting in implementation of environmental health priorities identified by the new EHT.

Concurrent with the training program, the MOH initiated organizational changes to consolidate all programs related to environmental health within a single department under the Director General of Environmental Health and Regulation. The move has elevated the emphasis given to environmental health services within the MOH and has improved coordination among all programs, including dengue control, with an environmental health focus or component.

What did not work?

The initial problem with environmental health services in Honduras was related to the highly compartmentalized, vertical structure of each of the disease-specific programs. Public health offices at the operational level included an army of field technicians, each working over a wide geographical area in one of six programs, such as dengue, malaria, environmental contamination, water and sanitation, and food inspection, with little coordination between them. Since each program maintained its own vertical structure for training, procurement, and support for the local specialist, the system was inefficient, expensive, and duplicative.

In addressing the problem of inefficiency and inadequate coordination at the local level, the MOH first proposed to develop a university degree program for environmental health specialists, with the goal of deploying these university-trained technicians as leaders at the local or regional level. However, after attempting to build an in-depth curriculum, it was determined that the approach would be a costly, long-term strategy, requiring decades to fully implement. It was also determined that a university program would not effectively utilize the substantial training and expertise found in the existing workforce of single program technicians.

That initial attempt led the MOH to focus instead on a training program to expand the skills of the most qualified technicians already working in single program areas. The process additionally revealed the need to incorporate EHTs into local and regional management teams. Prior to initiating the EHT program, environmental health activities were supervised primarily by physicians in the public health system. While many of the physicians had general knowledge of environmental health strategies, medical training is focused on clinical practice, and a resulting de-emphasis on environmental aspects of community health has occurred. By incorporating EHTs into regional management, prospects for strong support of environmental health activities are improved.

Sustainability

As local environmental health capacity is integrated into municipalities through the development of competent EHTs, sustainability will improve. The EHT program is currently sustained through the MOH with some local governments assuming responsibility of EHT staff within local budgets. Observations thus far in the effort indicate that municipalities gradually assume a greater responsibility for managing their own environmental health conditions and reduce the heavy dependence on centralized services, as well as assume a greater proportion of program costs.

Sustainability of public health programs in Latin America is often influenced by personnel changes occurring with each new administration. Building local environmental health capacity through qualified technicians, with a clear set of minimum job requirements, will help ensure program continuity and sustain competence during periods of political change.

Evidence that the practice works

By the end of 2002, nearly half of the EHTs had completed training and were fulfilling their functions within communities. Already, ample evidence exists that the effort is having a major impact on environmental health conditions. Virtually all of the field thesis activities (300 to date) provide solid evidence that the strategy works. The following paragraphs offer two examples resulting from field projects undertaken as part of the EHT training program.

Guasaule border crossing project

As late as the first few months of 2002, the major border crossing between Nicaragua and Honduras at Guasaule presented a chaotic mix of textile vendors, trucks, trailers, food stands, and households. Wastewater from a variety sources flowed uncontrolled through rutted streets toward the adjacent river, and garbage and rubbish from makeshift commercial stands filled every ravine and rut in the border district. After completing the EHT training course, the local EHT initiated a community risk assessment in cooperation with the Guasaule mayor and city council. At the suggestion of the EHT, the mayor tasked the community health committee with prioritizing problems and developing an intervention plan. With guidance from the EHT, the committee identified partners, including the Honduran Customs Agency, the municipality, regional health officials, and the Honduran transportation agency, to work on the priorities established through the Guasaule environmental health assessment. The results achieved through close inter-institutional cooperation are dramatic:

- A large open garbage pile in the heart of the commercial strip—a potential source of several disease vectors including *Ae. aegypti*--has been graded, cleaned, and filled, and now serves as a controlled parking area for trucks.

- Ravines and ditches have been cleaned of garbage—another source of breeding sites for disease vectors including mosquitoes. A series of refuse bins that are regularly serviced have been strategically placed along the commercial strip to replace the open dumps.
- Food vendors are now housed in enclosed structures.
- Wastewater has been routed through an enclosed conveyance system to a common settling (primary treatment) chamber before discharge downstream of the community.
- A vendors' marketplace has been consolidated and relocated to a common area adjacent to the main highway.

Healthy homes (viviendas saludables), Choluteca

As part of an overall strategy to reduce *Ae. aegypti* breeding sites and other health hazards in the urban area of Choluteca, the EHT for the metro area established a “healthy homes” program, and initiated inspection of all households in his area. Working in cooperation with the municipality and with community block leaders, the program publicizes the basic norms for a “healthy home.” The EHT and environmental health aides for the district then complete sanitary inspections of each home to assist residents in identifying hazards such as mosquito breeding sites, indoor air pollution from unvented charcoal stoves, and inappropriate wastewater or garbage disposal. The inspection provides a valuable opportunity to educate the public in dengue control methods while identifying other environmental health hazards. The inspection is followed by a return visit to ensure that steps have been taken to correct hazards that have been identified. The program is backed by a municipal code providing for enforcement fines for recalcitrant homeowners who refuse to correct or manage major hazards associated with their household.

Key points to remember

Key Point	Relative Importance*	Why?
Strong buy-in from senior levels of MOH	Critical	To overcome institutional resistance
A comprehensive training program	Critical	To allow for full integration of services
Appropriate organizational change	Critical	To engender strong organizational support
Environmental health tools and equipment	Very important	To ensure competent field performance
Utilize the existing workforce	Important	To build on existing capacity

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4. Conclusions

Although the 1994 PAHO and 1997 WHO guidelines note the importance of a paradigm shift in current approaches to dengue prevention and control, countries have not been able or willing to implement the changes to make their national dengue programs truly effective. As a result, no individual country has fully implemented a comprehensive, integrated dengue prevention and control program. However, support for the integrated approach is gaining momentum, as evidenced by the recent production of the *Planning Social Mobilization and Communication for Dengue Fever Prevention and Control: A step-by-step guide* (WHO, 2003), USAID-supported community-based formative research for dengue prevention and control activities in the Caribbean and Central American subregions and Cambodia, and a continued emphasis at regional and international meetings on full implementation of all components identified in the regional integrated strategy (PAHO, 2001) and the global strategy (WHO, 1996). Faced with ongoing DF/DHF epidemics, national programs will have to reexamine their current program strategy and evaluate its effectiveness on reducing the number of dengue cases or the mosquito vector population. Unless there are serious efforts to address existing program weaknesses, the region can expect to continue to suffer the negative impacts that result from DF/DHF epidemics.

The key points addressed in the table following this discussion reflect the top issues that programs will need to address to reform current program structures so that they incorporate the key elements of a comprehensive, integrated dengue prevention and control program. It is interesting to note that at least three best practices (Brazil, Vietnam, Dominican Republic) brought out the need for institutional changes to occur before new collaborative activities or program strategies could be implemented. In Brazil, the large-scale social mobilization activities could not be planned until the three levels of government (federal, state, and municipal) resolved a dispute over which agency was responsible for dengue control. In Vietnam, senior program staff had to overcome field staff resistance to using a new entomological surveillance method before it could be implemented at the community level. And in the Dominican Republic, staff noted that the negotiation strategy the program developed to work with residents on drum control methods challenged them to think and act differently as well.

Key points to remember

Key Point	Relative Importance	Why?
Thorough understanding of the 10 key elements of PAHO's integrated strategy (the Decalogue)	Critical	If senior MOH officials and national dengue program managers do not understand why all 10 elements need to be implemented, programs will continue to be ineffective.
Development of a comprehensive, integrated program in collaboration with key intersectoral partners	Critical	Ministries of Health cannot be solely responsible for dengue prevention and control because there are environmental and infrastructure factors beyond their responsibility.
Funding commitments that reflect the long-term processes required for sustained institutional and community behavior change	Critical	Behavior change does not take place overnight, nor will it occur in one year. Current annual budgets are unstable and rarely include support for activities beyond vector control. Therefore, funding over several years is needed before the changes will become institutionalized.
A focus on measurable behavioral outcomes at all levels: individual, household, community, private sector, and institutional	Critical	This does not exist in any dengue program to date; outcome indicators should be specific for each key element.
Effective and routine monitoring of program activities	Critical	Program staff must be continually aware of program progress and outcomes to determine when changes in program strategy are required.

4.1. Next Steps

Planning for comprehensive, integrated dengue prevention and control will require the following steps for programs to identify appropriate elements for inclusion:

- **Research:** Research into activities underway in other countries in the region will help identify processes and practices that may be appropriate for other settings. Unfortunately, most of these experiences are not published in scientific journals since they have been designed primarily as practical pilot projects, not research studies. Some of this information may be found on the dengue page of the PAHO

website (<http://www.paho.org/dengue>), as well as in reports of subregional meetings that include country presentations on the status of dengue control, individual country experiences in community participation, and recommendations for ongoing assistance from participants. Local USAID, PAHO, and WHO offices and international and national NGOs are also good places to start the research process since final reports and samples of communications materials from externally funded projects may be available. Another important area to research would be non-dengue projects; of particular interest would be projects that focused on environmental management, hygiene-related behaviors, and water and sanitation.

- Operations research and evaluation: Basic formative research and outcomes evaluation at the programmatic level are urgently needed to evaluate the field effectiveness of current program strategies. Using data from field evaluations and research findings from other areas or countries, a set of methods to be included under each of the 10 key elements can be defined, along with a description for implementation and evaluation of each. Countries may have a different mix of methods due to local political, environmental, and cultural settings. Ongoing evaluation will provide useful data to determine how effective the mix of methods is. For example, while campaigns can be very effective at raising community awareness and reinforcing messages received through other program components, they are not a substitute for community-based outreach activities. The decision to launch a campaign should be made based upon the desired behavioral outcomes (immediate or long-term changes) and an assessment of what mix of education, communications, and community methods will provide the desired changes.
- Interagency team: Designing an effective dengue prevention and control program that includes the 10 key elements will require the organization of an interagency team committed to working in partnership to address the many reasons why mosquito breeding and disease transmission continue throughout the region. Over time, good quality formative research and strategy design together with comprehensive program evaluation and monitoring should reduce the initial cost and effort for sustainable behavioral results. The measurement of behavioral results on an ongoing basis should be part of each key element of the dengue program, regardless of whether the element is vector control, clinical case management, or case reporting.

4.2. Program Expectations

What can be expected over the next year as countries work toward designing and implementing a comprehensive, integrated dengue prevention and control program? It is important to remember that behavior change, whether it is at the individual, community, or institutional levels, is incremental and that significant changes in each element will not take place in just one year. An important first step is to develop a detailed plan that includes measurable objectives for each of the key elements, describes the actions needed to improve program performance for each element,

identifies the department or agency responsible for effecting change for the element, identifies the technical assistance needs to implement the intervention, and describes the means by which change will be measured. Although it is unlikely that significant positive changes will be seen across all 10 key elements after just one year—and limitations in human, material, and financial resources would make it unreasonable to expect such high levels of change—there should be some measurable change in most of the key elements.

Every program has strengths and weaknesses. These should be assessed as part of the planning process so that all the partners have a common understanding of the strengths and weaknesses in each of the 10 key elements. Those elements that are the weakest should be targeted for immediate attention, taking into consideration current program concerns and desired long-term impacts. Technical assistance in the development of behavioral outcomes for each key element will also be needed (see Annex 1), as well as assistance in field testing the efficacy of vector control methods currently in use, including chemical, physical, and biological control techniques. As the comprehensive, integrated dengue prevention and control program moves towards full implementation, the number and size of DF/DHF epidemics is expected to decline, reducing the burden of disease on the country.

Annex 1

International Organizations

The following is a list of international organizations active in DF/DHF prevention and control (in alphabetical order). (This is not a comprehensive list.)

1. The CHANGE Project

Academy for Educational Development (AED)
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Website: <http://www.cdc.gov/ncidod/dvbid/dengue> (English)
<http://www.cdc.gov/spanish/enfermedades/dengue.htm> (Spanish)

3. Johns Hopkins University, Bloomberg School of Public Health

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4. Pan American Health Organization (PAHO)

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<http://www.paho.org/spanish/hcp/hct/vbd/dengue.htm> (Spanish)

5. World Health Organization (WHO)

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Annex 2

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World Health Organization. 2003. *Planning Social Mobilization and Communication for Dengue Fever Prevention and Control: A step-by-step guide*. Geneva: WHO. (Guide currently in field trials and not available for general distribution).

Annex 3

Use of Temephos in Water for Human Consumption

For information on the use of temephos in water for human consumption, please consult the following documents:

PAHO. 1994. *Dengue and dengue hemorrhagic fever in the Americas: Guidelines for prevention and control*. Scientific Publication No. 548 (in English and Spanish). Washington, D.C. <http://www.paho.org/english/hcp/hct/vbd/dengue.htm>.

Chavasse, D.C., and H.H.Yap. 1997. *Chemical methods for the control of vectors and pests of public health importance*. Geneva: World Health Organization. WHO/CTD/WHOPES/97.2.

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Annex 4

Other Resources

Permission was given to include the following information from the *Planning social mobilization and communication for dengue fever prevention and control: A step-by-step guide* (WHO, 2003).

1. Internet Sites to Help Find Articles

- Free medical journals: <http://freemedicaljournals.com>. Access to 990 free journals.
- The National Library of Medicine: http://www.ncbi.nlm.nih.gov/entrez/journals/noprov/loftext_noprov_A.html. PubMed full journal list but varying degree of access to material without subscription.
- Health InterNetwork: <http://www.healthinternetwork.net>. General access to abstracts without subscription. Institutions in countries with GNP per capita below US\$1,000 are eligible for free access to full articles on subscribing. Institutions in countries with GNP per capita between US\$1,000-\$3,000 are eligible for access at reduced prices.
- INASP (International Network for the Availability of Scientific Journals): <http://www.inasp.org.uk> / <http://www.inasp.org.uk/health/links/contents.html>. A co-operative network aiming to improve worldwide access to information. It contains information on the best ways to obtain journals in different parts of the world and also contains a database for many abstracts of African journals.

2. Useful Internet Sites

- The Communication Initiative: www.comminit.com. A partnership of development organizations seeking to support advances in the effectiveness and scale of communication interventions for positive international development. It provides information on communication and development experiences and thinking, links people engaged in communication action, provides peer commentary on programs and strategies, and tries to promote strategic thinking on communication, development issues, and problems.
- InterWATER: <http://www.wsscc.org/interwater>. Offers information about more than 600 organizations and networks in the water supply and sanitation sector in developing countries.

- *Scaling up the response to infectious diseases: A way out of poverty*. Geneva: World Health Organization. WHO/CDS/2002.7: <http://www.who.int/infectious-disease-report/2002/index.html>. This WHO report outlines how increased investment in health can be well spent, stressing how interventions, health system strengthening, and behavior change together can help achieve global health goals. It is intended to provide the broad outlines of a single “road map” to scaling up efforts to control the major diseases of poverty: malaria, HIV/AIDS, and tuberculosis. While no single plan will suit every country, this report points toward models that can be emulated and policies and initiatives that have yielded repeated success and that can be extended to provide direction for the emerging global movement against diseases of poverty.
- Healthy Cities: <http://www.who.dk/healthy-cities>. Website provided by the WHO Regional Office for Europe describing Healthy City news and events, technical documents, case studies, strategy documents, newsletters, links to Healthy Cities (European), contacts, and services provided by the regional office (including information, training and capacity building, representation and consultancy, networking, and international cooperation).
- Links to programs promoting sustainable cities: <http://www.cleancities.net/suscities.html>. This web page is produced in support of the Philippine Clean Cities Project. Contains many useful web links to key international organizations associated with healthy cities, Asian sustainable cities’ programs, and other great resources.
- Professional educational materials: <http://www.cdc.gov/ncidod/dvbid/dengue>. A complete slide set developed for public health professionals can be downloaded in a variety of formats, next page:

**Dengue: Clinical and Public Health Aspects
(a slide set for health care professionals)**

Section	Web version	Table of contents	PowerPoint version
Introduction	4 slides	Intro	—
I. Virus, Vector, and Transmission	8 slides	I	981 KB
II. Disease Surveillance and Control	9 slides	II	247 KB
III. Clinical Manifestations of Dengue and Dengue Hemorrhagic Fever	17 slides	III	304 KB
IV. Epidemiology	9 slides	IV	326 KB
V. Disease Pathogenesis	12 slides	V	278 KB
VI. Diagnosis	21 slides	VI	4.85 MB
VII. Treatment	13 slides	VII	254 KB
VIII. Prevention	17 slides		

3. General Dengue References

Gubler, D.J., and G. Kuno, eds. 1997. *Dengue and dengue haemorrhagic fever*. London: CAB International Press.

Halstead, S.B., and H. Gomez- Dantes, eds. 1992. *Dengue: A worldwide problem, a common strategy*. Ministry of Health of Mexico and the Rockefeller Foundation. Mexico City: Ministry of Health of Mexico.



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